AIRBORNE ALL-STARS

YASUAKI NINOMIYA

Paper Flying Models of Famous Aircraft

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Preface

Each time I see a jet streaking across the blue sky, its vapor trails stretched out behind, I once again feel a strong wonder and fascination for the beauty and ability of aircraft. The desire to examine these aircraft from close at hand is probably the reason for the popularity of scale model planes.

Although planes are beautiful on the ground, they also have an active beauty apparent only in flight. Because it is impossible to enjoy their dynamic grace and power from desk-top scale models alone, some people build radio-controlled or free-flight flying models, but these are not only difficult to construct they are also hard to fly. Paper models, on the other hand, are much easier, and I hope that this book will assist both young people and busy adults in making and flying models of famous aircraft.

There are certain aerodynamic requirements which paper flying models must meet in order to fly well. In addition they must be strong enough to withstand repeated striking against the ground or walls. The design must be light and strong and parasite drag must be reduced to the minimum. In order to meet these requirements all the paper planes in this book are based on profile models. As I explained in *Jet-Age Jamboree*, the first volume in this series, the fuselages of these models consist of several pieces of paper glued together. Furthermore, the noses are reinforced with extra paper.

For this book, I choose fifteen famous propeller and jet aircraft from all over the world. All easy to build they may be hand thrown or launched from a rubber-band catapult.

At the end of the book I explain how to make your own patterns from airplane magazines or yearbooks.

July, 1969

YASUAKI NINOMIYA

Contents

CESSNA 210 "Centurion"

NAMC YS-11

BOEING 747 "Jumbo Jet"

AERMACCHI MB 326

BOEING 727

LOCKHEED F-104 "Starfighter"

"Concord"

BEAGLE 121 "Pup"

Materials

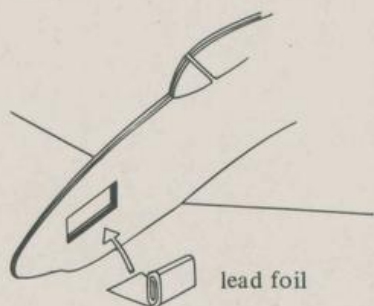
Paper: Selection of paper is very important. For best results, use either thick drawing paper or Kent drafting paper.

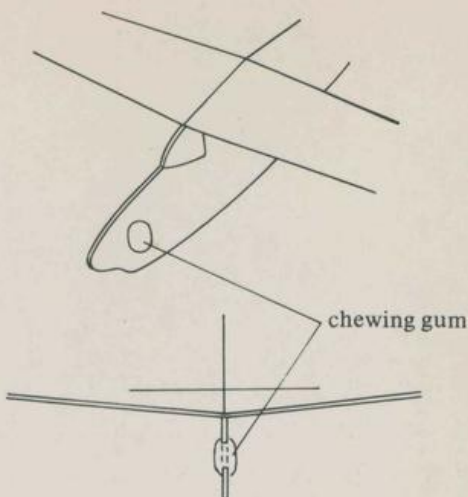
Glue: Quick drying glue is best. Cellulose based glue is ideal because it is quick drying and contains no water, which can be absorbed into the paper to cause wrinkles.

Weights: A weight on the nose of the plane is necessary in order to adjust the center of gravity. Any of the following weights will do; choose the easiest one to work with.

1) *Paper clips:* It is easy to adjust the center of gravity by using large or small clips. See 1-1.

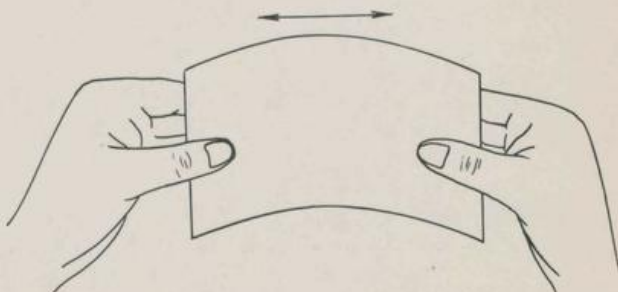
[1-1] Put paper clips on the nose for weight.

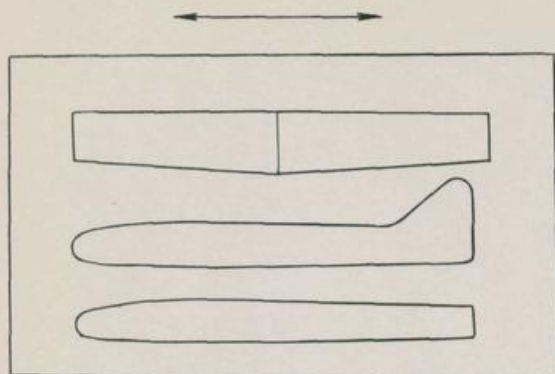
2) *Lead foil:* This is good for sealing into the nose of your model as in 1-2. Read PIAGGIO P136-L for directions on adjusting the center of gravity.

[1-2] Cut a hole in the nose, insert rolled lead foil weight, and glue paper over the hole.

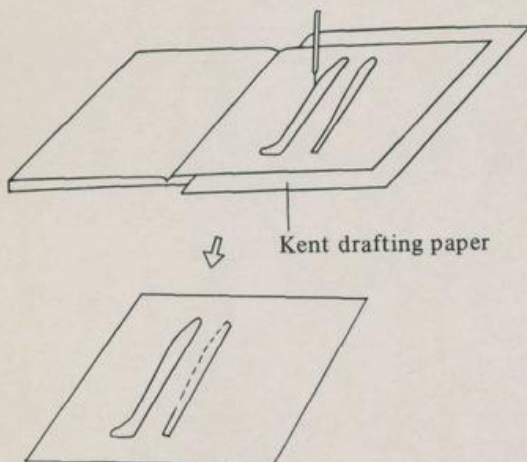
3) *Chewing gum:* This is probably the easiest to obtain. A 1/8- or 1/4-inch round hole is cut into the nose, and well chewed gum is packed it. See 1-3.

[1-3] Cut a hole in the nose, and insert chewing gum for weight.

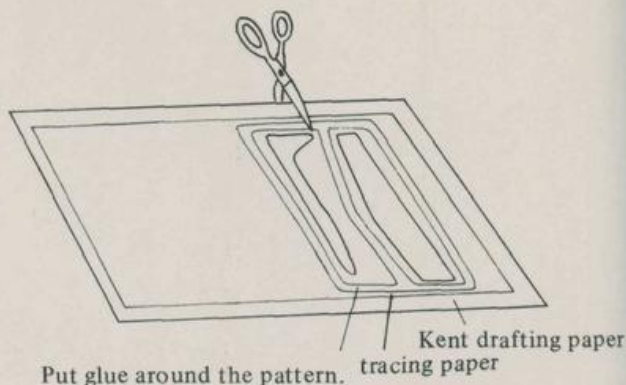
Paint: Use waterproof ink or lacquer. For directions see Section "Painting Details."

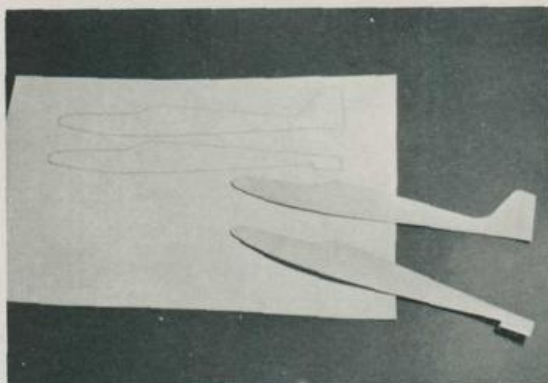
Patterns

To copy the patterns on Kent or drawing paper follow any one of the following four methods, but always place the fuselage and the wing so that its length agrees in direction with the stiffer grain of the paper. Although it seems the same from all angles, paper is, in fact, stiffer in one direction than in another. Illustrations 2-1 and 2-2 will clarify this point.

[2-1] Bend the paper to find the direction of greater resistance.

Direction in which the paper is difficult to bend.

[2-2] The wings and fuselage of the plane must lie along the stiffer grain.

Method 1. Put the drawing paper or Kent drafting paper under the page that has the pattern you wish to copy. Push a needle through the page along the pattern lines and into the model paper. Where the pattern lines curve keep the needle holes close together to make it easy to connect them later. When you have finished making holes along all the pattern lines, take the model paper out and connect them with a pencil as shown in 2-3. Use a hard lead pencil, and draw lightly so that your model will be clean when finished.

[2-3] Put a sheet of Kent drafting paper under the pattern, and push a needle through along the lines and into the drafting paper. Next take the paper out, and connect the needle holes with a pencil.

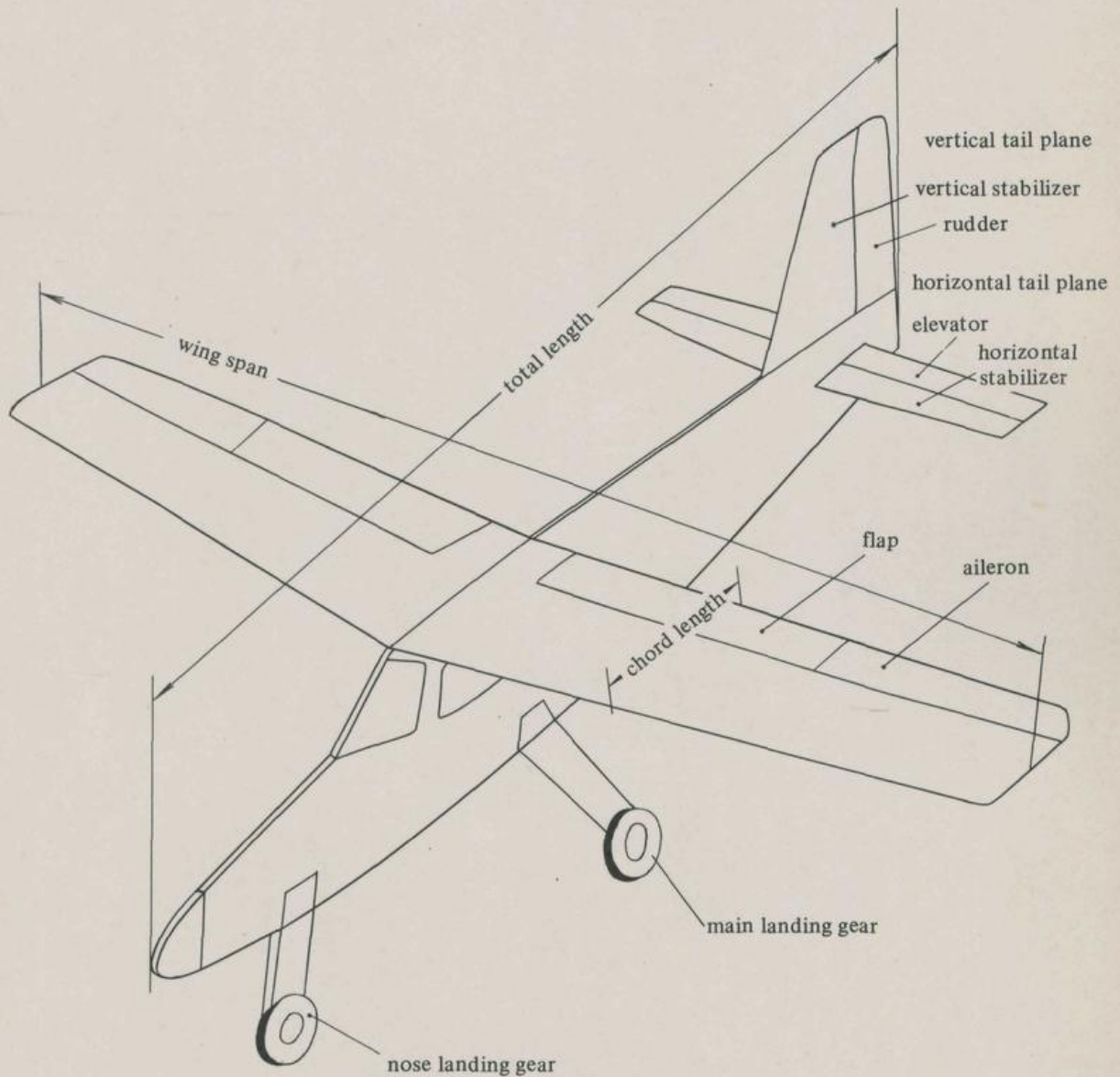
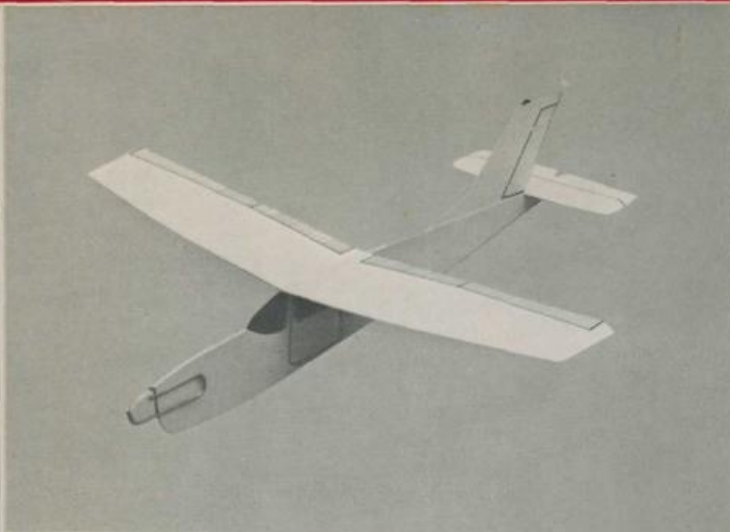
Methods 2. Put tracing paper (or any very thin paper) over the pattern, and trace it with a pencil. Next turn the tracing paper over, and put glue all around the outside of the pattern (2-4). Then put the tracing paper, glue side down, on the model paper, and cut through both.

[2-4] Copy the pattern on tracing paper, and glue it to the Kent drafting paper. Then cut them together.

Methods 3. If you want to several planes with the same pattern you must make a permanent pattern outline. To do this, copy the pattern from the book on tracing paper just as in method 2. Then after coating thick mounting paper with glue, put the tracing paper on it carefully so there are no wrinkles; let the glue dry. Now cut the pieces out. Use a freshly sharpened pencil, and follow the outline closely to make an accurate copy (2-5). This permanent pattern outline can be used and over again.

[2-5] If it is made of sturdy mounting paper, you can use the pattern over and over again.

Method 4. Reproduce the pages of this book on a copying machine, and use this as your pattern. Finish your cutting with method 2 or 3.

Aircraft Parts

Before I explain how to make models, you should know some of the names of aircraft parts.

[3-1] Parts of an aircraft

CESSNA 210 "Centurion"

GLUING THE PARTS TOGETHER

Use fast drying glue.

Apply plenty of glue to both the wing and fuselage parts; then lay them on a flat board to dry for from five to six hours. After the wings and fuselage dry, glue the tail and wings to the fuselage, and allow them to dry for three more hours.

Put the arrow point to the front.

Glue wing backing ⑦ to the wing ⑥ before gluing to the fuselage.

⑥

⑦

Put the arrow point to the front.

⑧

Glue tail ⑧ here.

⑤

③

①

Glue wing ⑥ to ⑦ to this tab.

Glue the fuselage parts together in the order shown.

②

④

MAKING ADJUSTMENTS

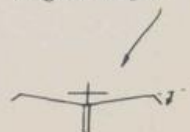
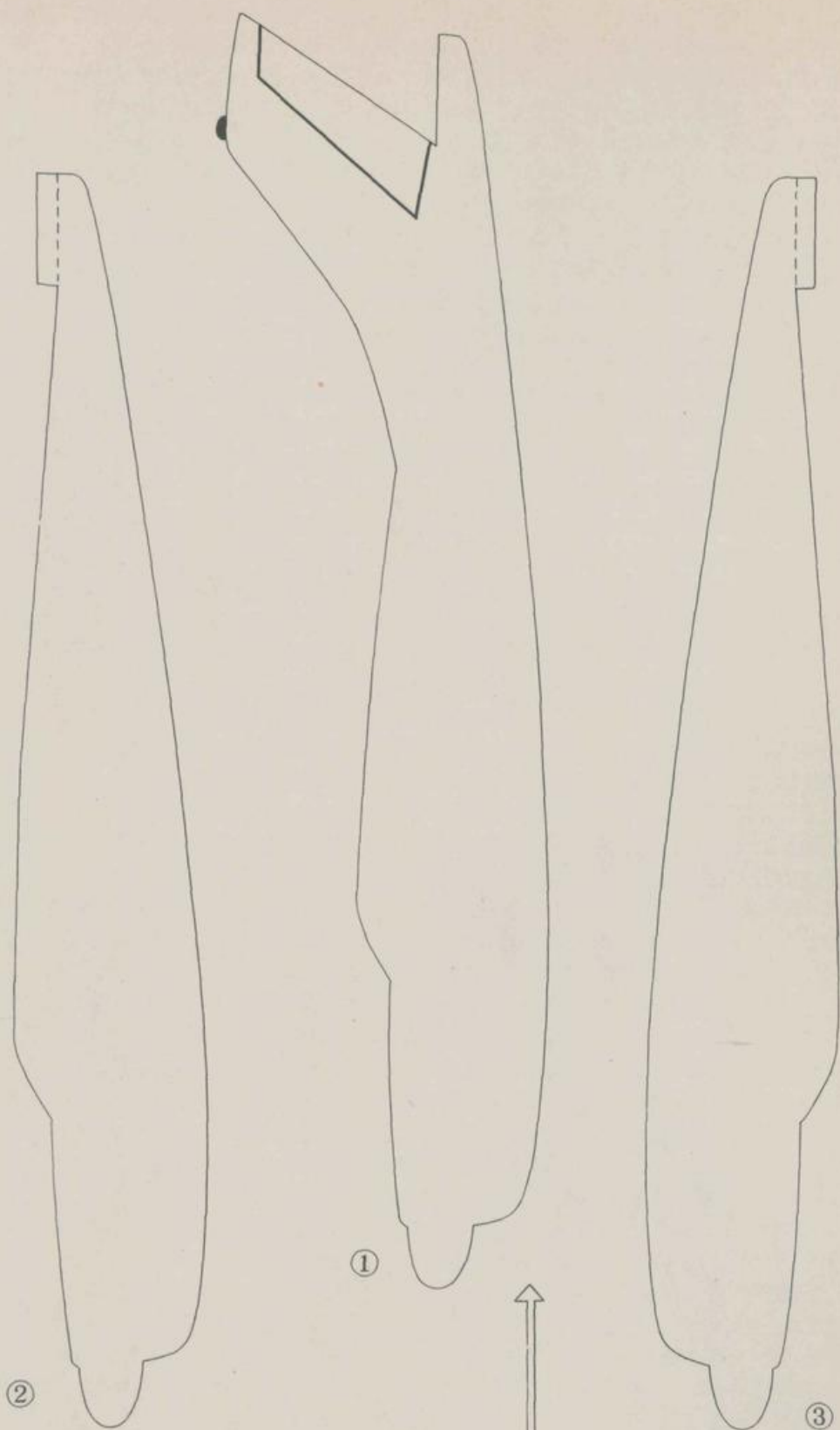
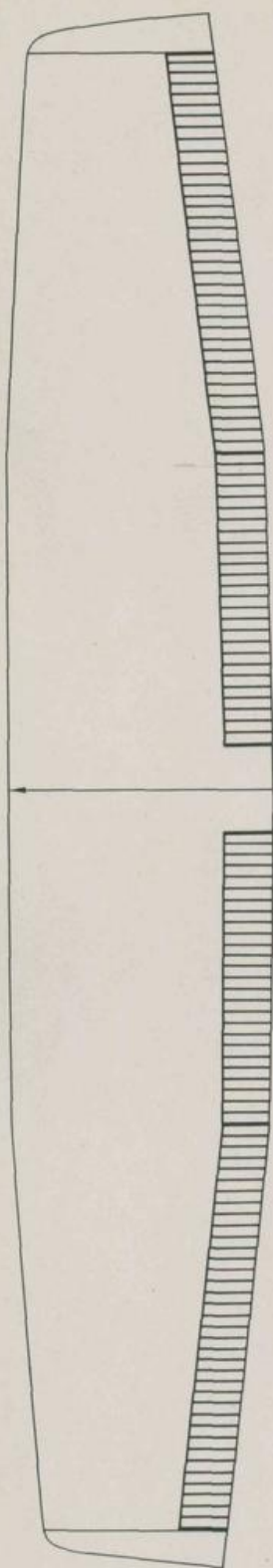
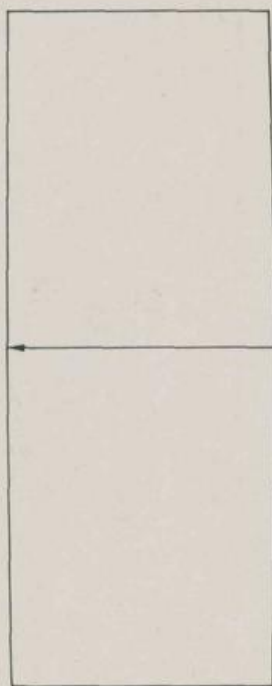
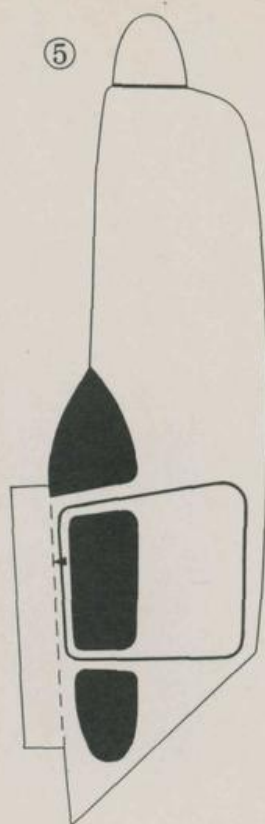
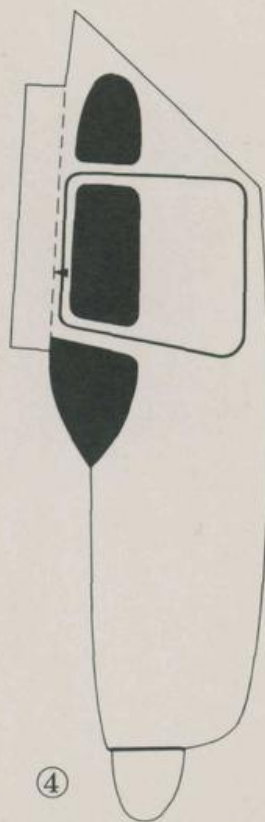
Make adjustments only after the plane is completely dry.

Round the wing surface.

Dihedral angle of 10 degrees.

First, look down the nose, and straighten any bends and twists in the fuselage or wing.

Add paper clips to the nose to adjust the center of gravity to the ▲ mark on the wing attaching position of the fuselage.

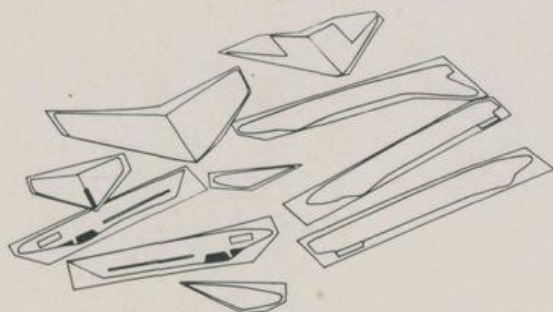
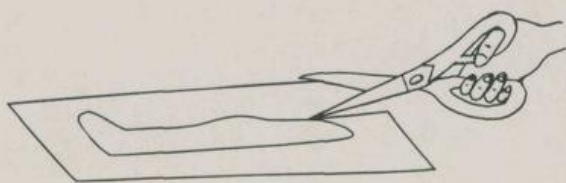
Fold the wing tips down along this line to form a 45-degree angle.

The arrow indicates the direction in which the paper is stiffer.

⑥
⑦
⑤
⑧
④

Construction Methods

, I will start with an easy-to-build and easy-to-fly model based on the light CESSNA "Centurion." The construction of the model transports and fighters, which I introduce later, is practically the same.

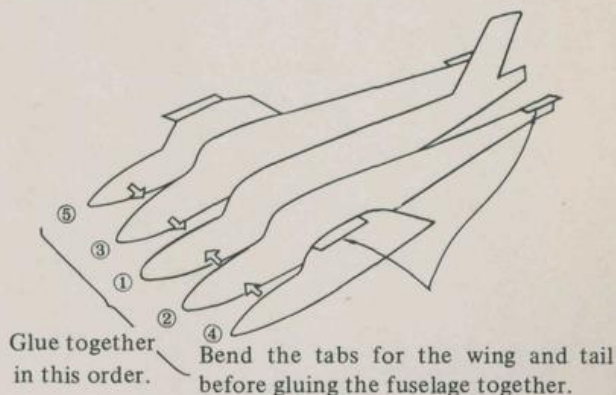
COPYING THE PATTERNS

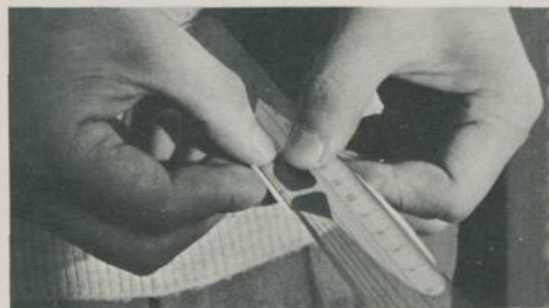
Choose the copying method you like best, and for a sturdy airframe be sure that the fuselage and wings are drawn to lie in the direction in which the paper is stiffer (2-1 and 2-2).

CUTTING OUT THE PIECES

After you have copied the pattern, cut the pieces out. In order to do a good job, first cut them out in rough size as shown in 4-1; trim them carefully along the lines (4-2). In this way you can concentrate on one piece without worrying about spoiling any of the others or bending the paper. Be sure to use very sharp scissors.

[4-1] First cut all the pieces out roughly.

[4-2] Next cut carefully along the pattern lines.

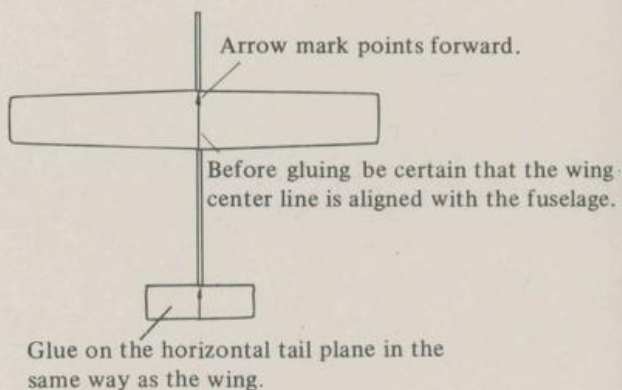
GLUING THE PARTS TOGETHER

If you want a strong model that flies well you must glue the parts together carefully. The fuselage part numbered ① will be in the center, with numbers ② and ③ on its left and right. Glue the parts in order as shown in 4-3. Coat with glue all of the surfaces to be joined, and fit them together quickly and accurately. Next put these parts between two spare sheets of papers, and press them firmly with your fingertips as shown in 4-4. Wipe away excess glue, and proceed with the next part in the same manner. Bend the wing tabs and the tail tabs on fuselage parts②,③,④, and ⑤ before gluing them to the fuselage (4-5).

[4-3] Fuselage assembly order.

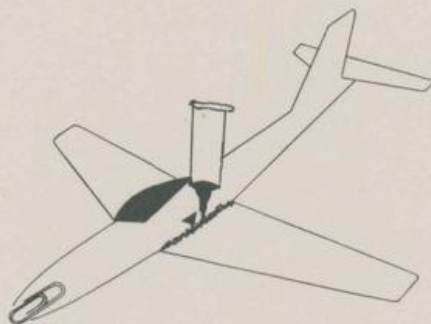
[4-4] After the fuselage is glued, put it inside a folded sheet of paper to press out the excess glue.

[4-5] When folding the wing and tail tabs, hold a ruler along the line so that the fold will be straight.

After fuselage parts ① through ⑤ have been glued together, spread a sheet of paper on top of a table, and lay the fuselage on it to dry (4-6). Now glue the backing (⑦) to the rear of the wing (⑥) in the same way and let it dry (4-7). Instead of drying the fuselage and wing on a flat surface you might put them between the pages of a book. However, be sure to protect the book from the excess glue (4-8) with extra sheets of paper. Even through you use a fast-drying glue it will take several hours for the fuselage to dry thoroughly because of the number of parts. Simply wait patiently.

After the fuselage and main wing parts are completed, glue the fuselage wing tab to the wing so that the wing center line aligns with the fuselage (4-9). Glue on the horizontal tail plane in the same way. Next, as shown in 4-10 apply plenty of glue to the seams where the wing and tail touch the fuselage. Once more, wait until the glue has thoroughly dried.

[4-8] When drying the fuselage or wings in a book use spare sheets of paper to protect the book.

[4-9] Glue the center line of the wings and horizontal tail plane so that they align with the fuselage.

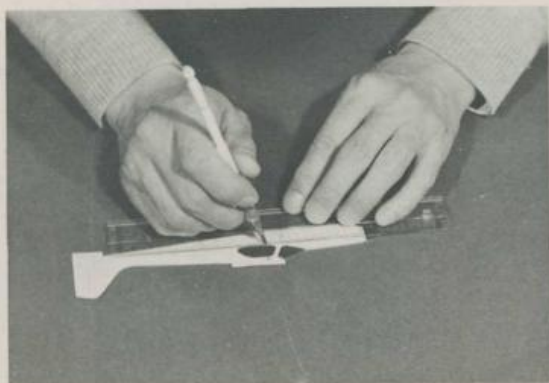
[4-6] Spread paper on a desk or table and lay the part to be dried on it.

[4-7] Glue the backing to the center of the wing.

[4-10] Apply plenty of glue to the seams between wing and fuselage and tail and fuselage.

Painting in Details

Painting a black canopy on the white body of the plane is simple and looks very good (5-1). Use a ruler as a guide and paint the canopy before you glue on the fuselage and tail (5-2).

When an unpainted paper plane becomes soiled it is difficult to clean. Remedy the situation by applying a coat of clear lacquer which is both attractive and protective. Avoid, or limit to an absolute minimum, oil paints, which are too heavy, and water paints, which cause wrinkles.

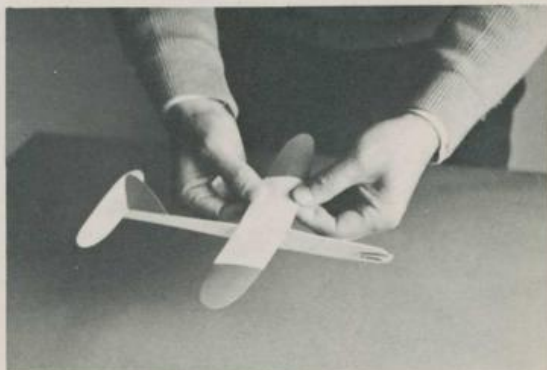
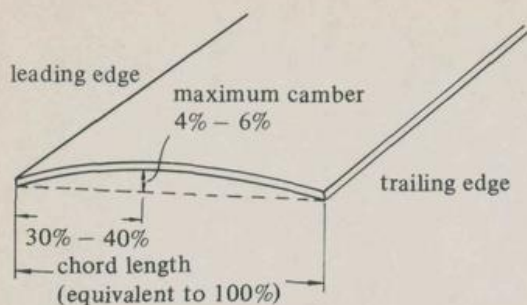
[5-1] A black canopy contrasts well with a white fuselage.

[5-2] It is much easier to draw the canopy and other details before attaching the wings and tail.

Adjustments

When you have completed the airframe, wait until the glue and paint have thoroughly dried. If you fly the plane before it is dry, the fuselage or wings might bend or even fall off. Furthermore, until the plane is completely dry the position of the center of gravity can change slightly.

1. First examine the plane for bends and twists. Correct any you find as shown in 6-1.

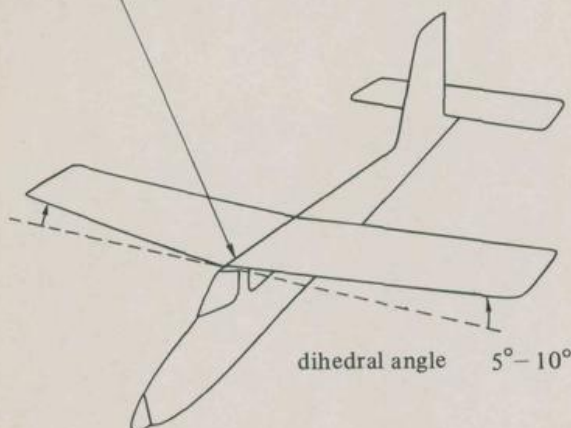
[6-1] Holding the plane as shown, correct any bends and twists in the fuselage or wings.

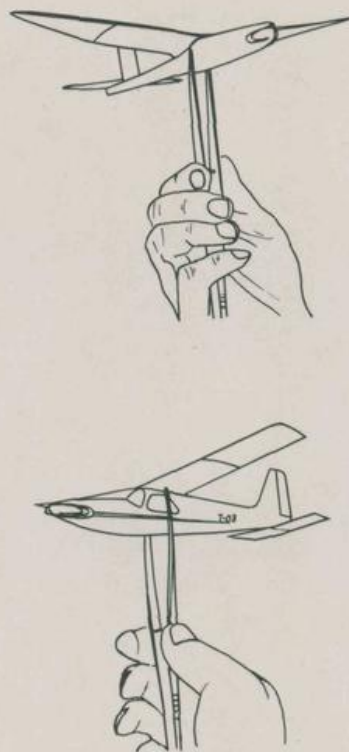
2. Next shape the camber of the wing as shown in 6-2. See 6-3 for details on how much this should be done.

[6-2] Shaping the wing cross section.

A 4% – 6% camber should be formed at 30% – 40% of the distance from the leading edge.

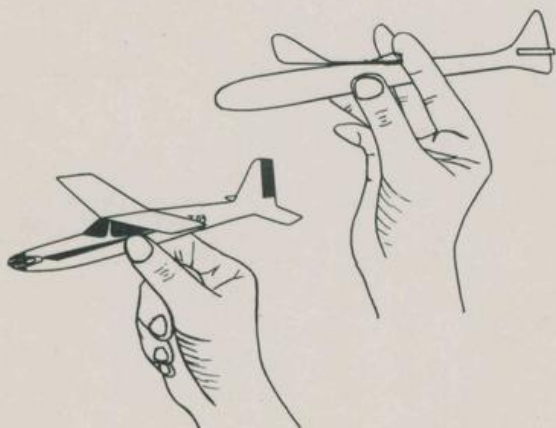
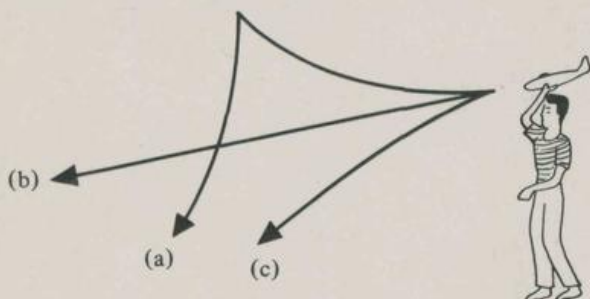
[6-3] Cross section of an efficient wing.

3. In order to improve lateral stability, bend the wings up slightly to form the dihedral angle shown in 6-4. The CESSNA "Centurion" is a high-wing plane requiring a dihedral angle of 5 or 10 degrees.

The adjustment for the proper dihedral angle for each plane in this book is given together with the pattern. Since the lower the wing, the poorer the lateral stability, a low-wing plane needs a large angle (8-8).

Make a slight upper fold in the center line of the wing for the dihedral angle.

[6-4] Dihedral angle

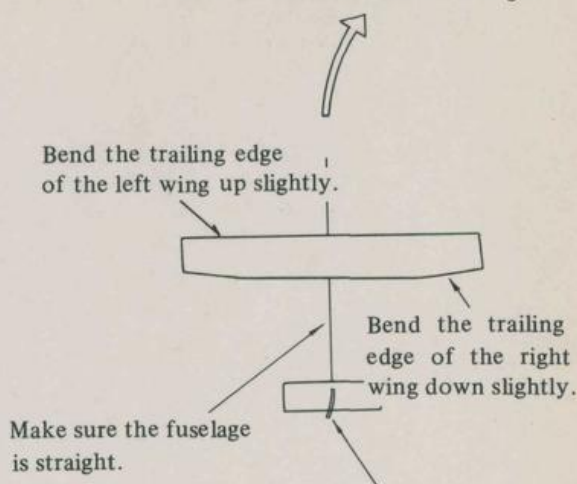
4. A triangular mark (▲) appears on all the wing tabs on the patterns in this book. The center of gravity should be aligned with this mark. To change the center of gravity put bigger or smaller paper clips on the nose of the plane. If you hold the plane with tweezers as shown in 6-5 you can find the center of gravity quickly. Use the method shown in 8-11 to find the point to which the center of gravity should be aligned for models you design yourself.

[6-5] The center of gravity is apparent if you hold the plane with tweezers.

5. Now look down the nose of the plane once more, and correct any twists or bends in the fuselage or wings. Then toss the plane gently to observe how it flies. Hold it as in 6-6, and toss it on a line slightly on or below the horizon. If it glides smoothly, as in (b) of 6-7, you have no problems; but if it climbs and stalls, as in (a), or drops, as in (c), make the indicated adjustments. If, when you toss it straight forward, it turns right or left, either the wings, vertical tail plane, or the fuselage is bent; correct as shown in 6-8. The adjustment explained in 6-8 is for correcting a turn to the right; for correcting a turn to the left reverse the procedure. When you make test flights indoors, fly the plane toward a curtain, which will act as a cushion to protect the airframe from damage (6-9).

[6-6] The proper way to hold the plane.

(a) Bend the trailing edge of the horizontal tail plane down slightly.

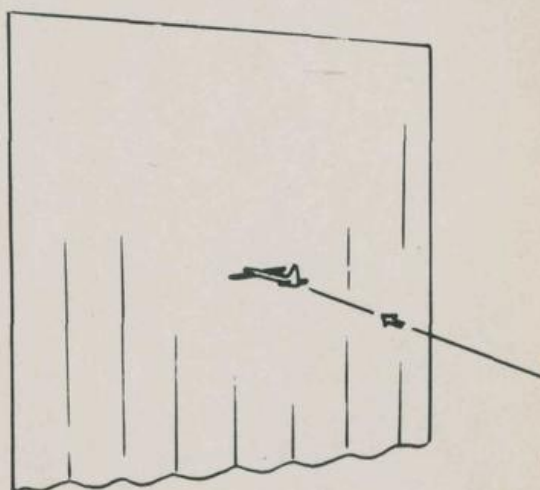
(b) Just right.

(c) Bend the trailing edge of the horizontal tail plane up slightly.

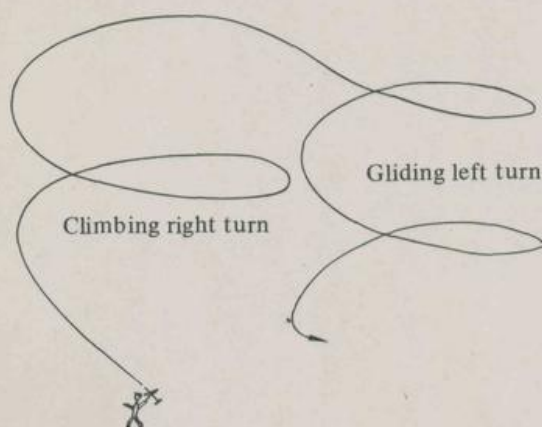
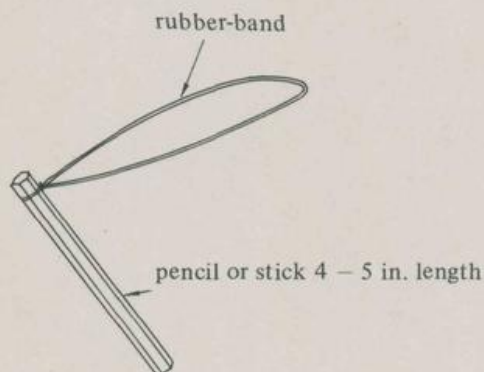
[6-7] Throw the plane on a line slightly below the horizon, and observe its flight.

How to correct a turn to the right.

Bend the trailing edge of the vertical tail plane slightly.

To correct a turn to the left reverse the procedure.

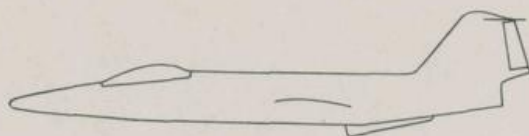
[6-8] If the plane turns left or right, even if there is no wind, you can correct as above.

[6-9] If you fly your plane into a curtain or hanging blanket it will not be damaged.

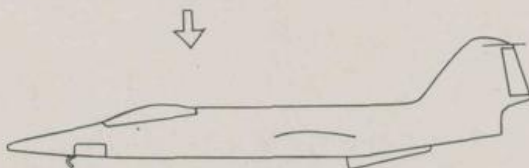
Flying

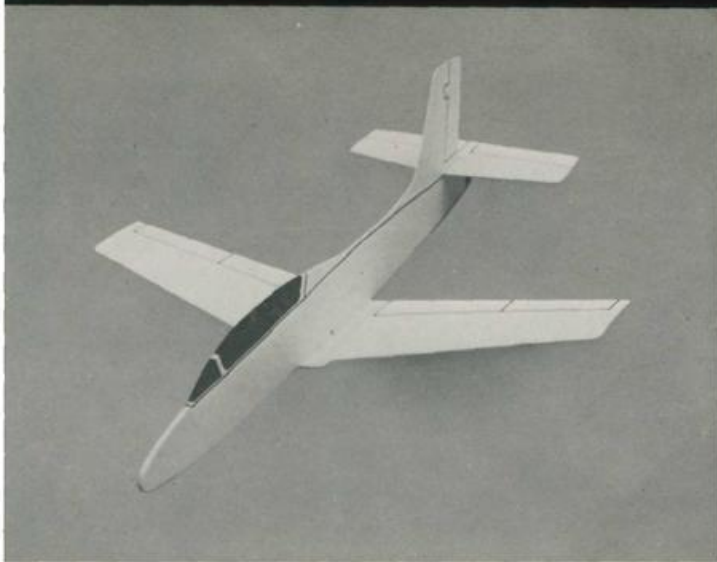
When flying your model outdoors remember the following. If you throw the plane directly forward and up, it will go into a loop and return to lose altitude. Therefore, when throwing it with your right hand, adjust the wings and vertical tail plane so that the plane turns to the left when launched gently. After you have made these adjustments, hold the plane in your right hand so that the airframe points diagonally up and to the right, and throw it as hard as you can. The plane will climb turning to the right and then settle into gliding left turns (7-1). Left-handed people must reverse the flying method.

[7-1] Adjust the plane for a left turn before throwing. If you throw the plane up to the right it will make a climbing right turn and then settle into a glide while turning left.

[7-2] Rubber-band catapult launcher.

Hold the plane as shown in 6-6.

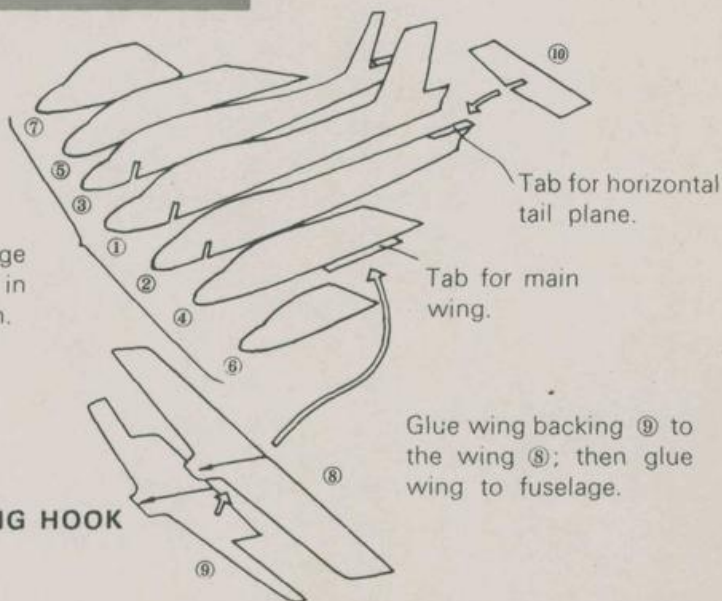
Models with extreme swept-back wings and large angles of attack often fly unsteadily and go into wing tip stalls and spins. When making adjustments in the horizontal tail plane of such craft, make certain that the nose does not rise.

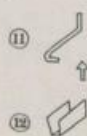
Instead of flying planes by hand you might like to make a rubber-band launcher by attaching a 1/16-inch rubber band to the end of a pencil 4 or 5 inches long (7-2). Insert a catapult hook into the nose of the plane (7-3), and slip the rubber band into it for launching (7-4). Additional rubber bands provide greater speed, but since paper planes are comparatively weak, do not use more than four. Fighter models, which fly especially well from rubber bands, perform thrilling low-level flights if launched just above the surface of the ground.

Make a hook by bending a paper clip. Insert it into the fuselage.

Glue paper over the outside to hold the hook in place.

[7-3] How to attach the catapult launching hook.

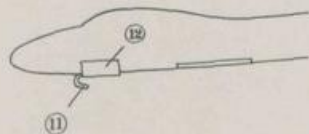
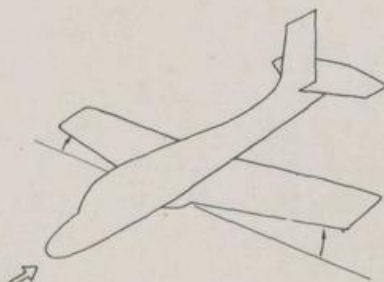
[7-4] Launching with a rubber-band catapult.

AERMACCHI MB 326

GLUING THE PARTS TOGETHER

Glue the fuselage parts together in the order shown.

Glue wing backing ⑨ to the wing ⑧; then glue wing to fuselage.

ATTACHING THE LAUNCHING HOOK FOR A RUBBER CATAPUIT

Bend a paper clip into the shape shown ⑪ and insert it into the hole in the fuselage. Then glué paper cover ⑫ over it as shown to keep it in.

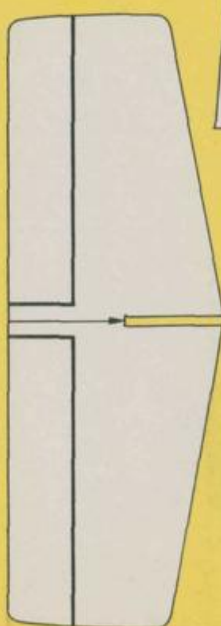
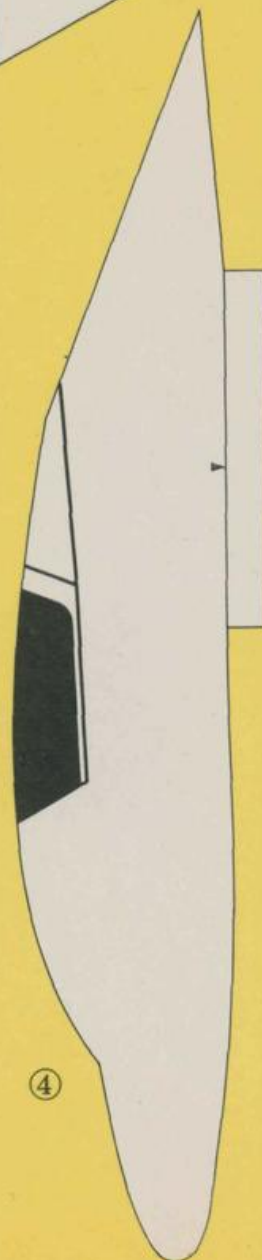
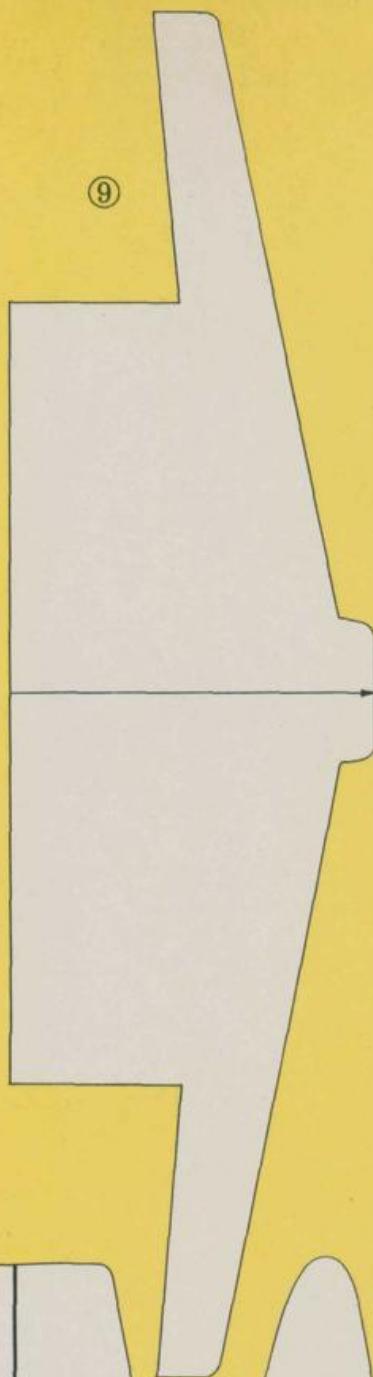
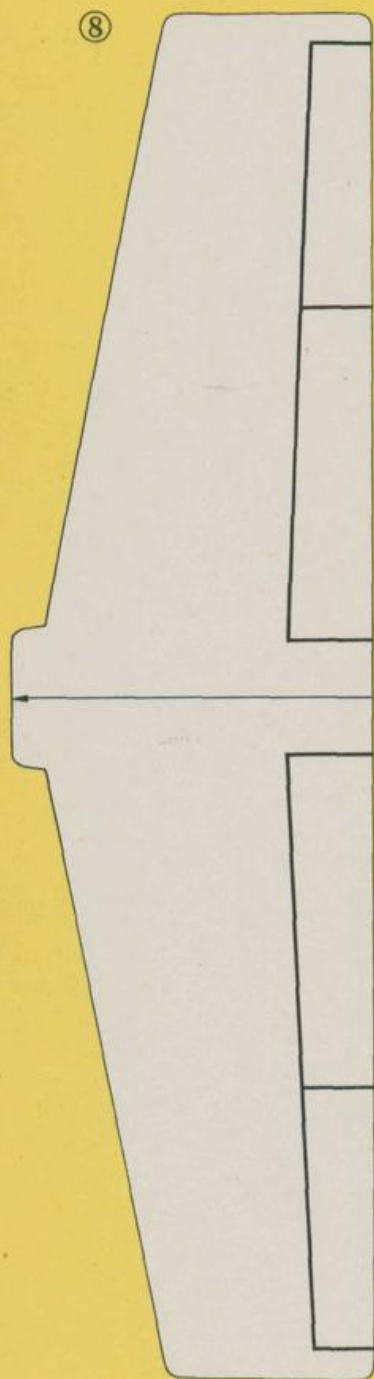
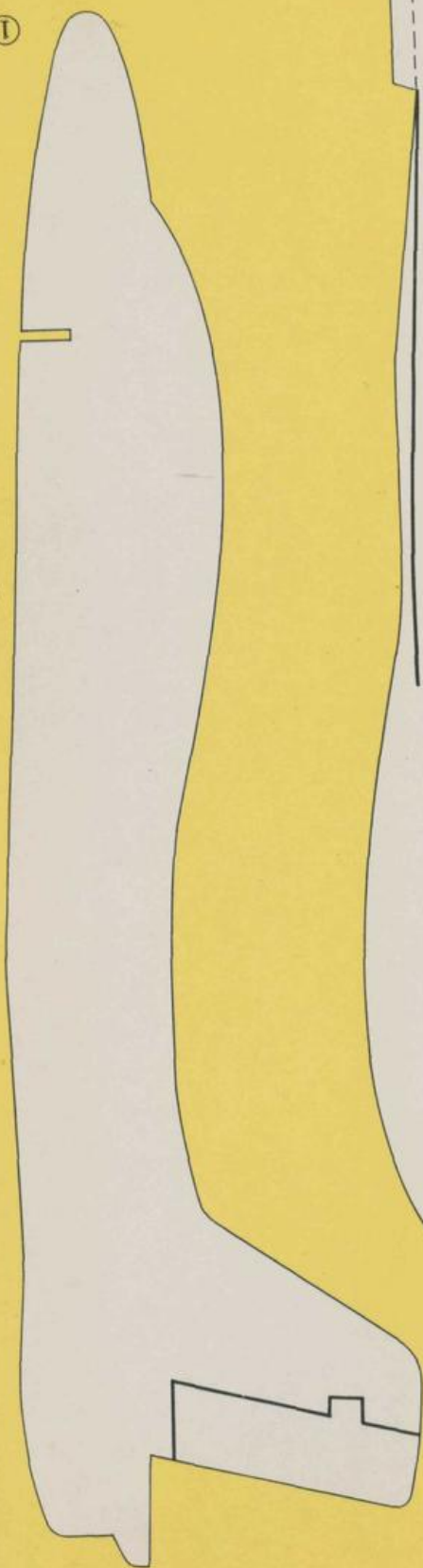
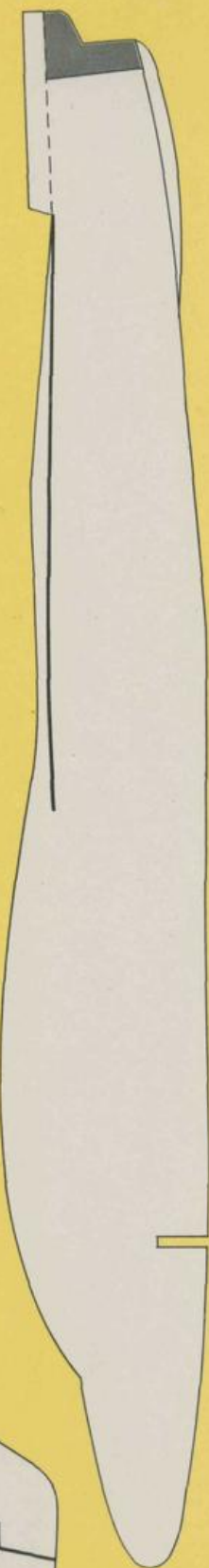
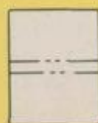
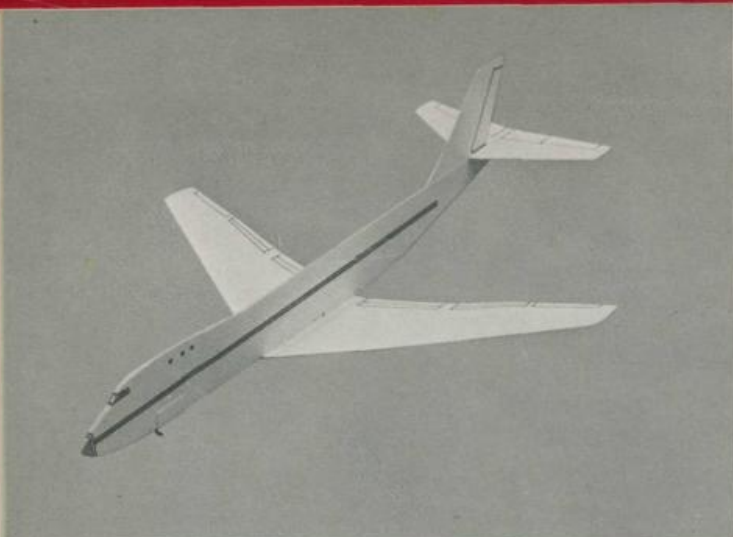
MAKING ADJUSTMENTS

Allow the plane to dry for more than five or six hours before making adjustments. The center of gravity in this plane can be adjusted to the ▲ mark without adding weight to the nose.

Look down the nose, and straighten any bends in the wing, fuselage, or tail.

Dihedral angle of from 10–20 degrees.

⑥
⑨
⑧
④
⑩
⑦

⑪ ⑫

⑤

③ ② ①

BOEING 747
"Jumbo Jet"

Glue the horizontal tail plane to the tabs.

Tab for horizontal tail plane.

Tab for main wing.

GLUING THE PARTS TOGETHER

Use plenty of glue, and allow the plane to dry undisturbed for five or six hours.

Glue the fuselage parts together in the order shown.

ATTACHING THE LAUNCHING HOOK FOR A RUBBER CATAPULT

When making a catapult hook bend a paper clip into the shape shown in ⑫ and insert it into the fuselage. Glue paper cover ⑪ over it to keep it in.

Glue wing backing ⑨ to the wing ⑧ before gluing it to the fuselage.

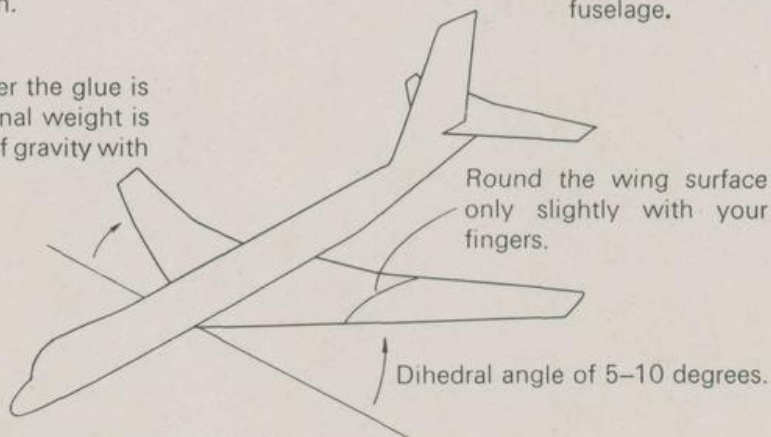
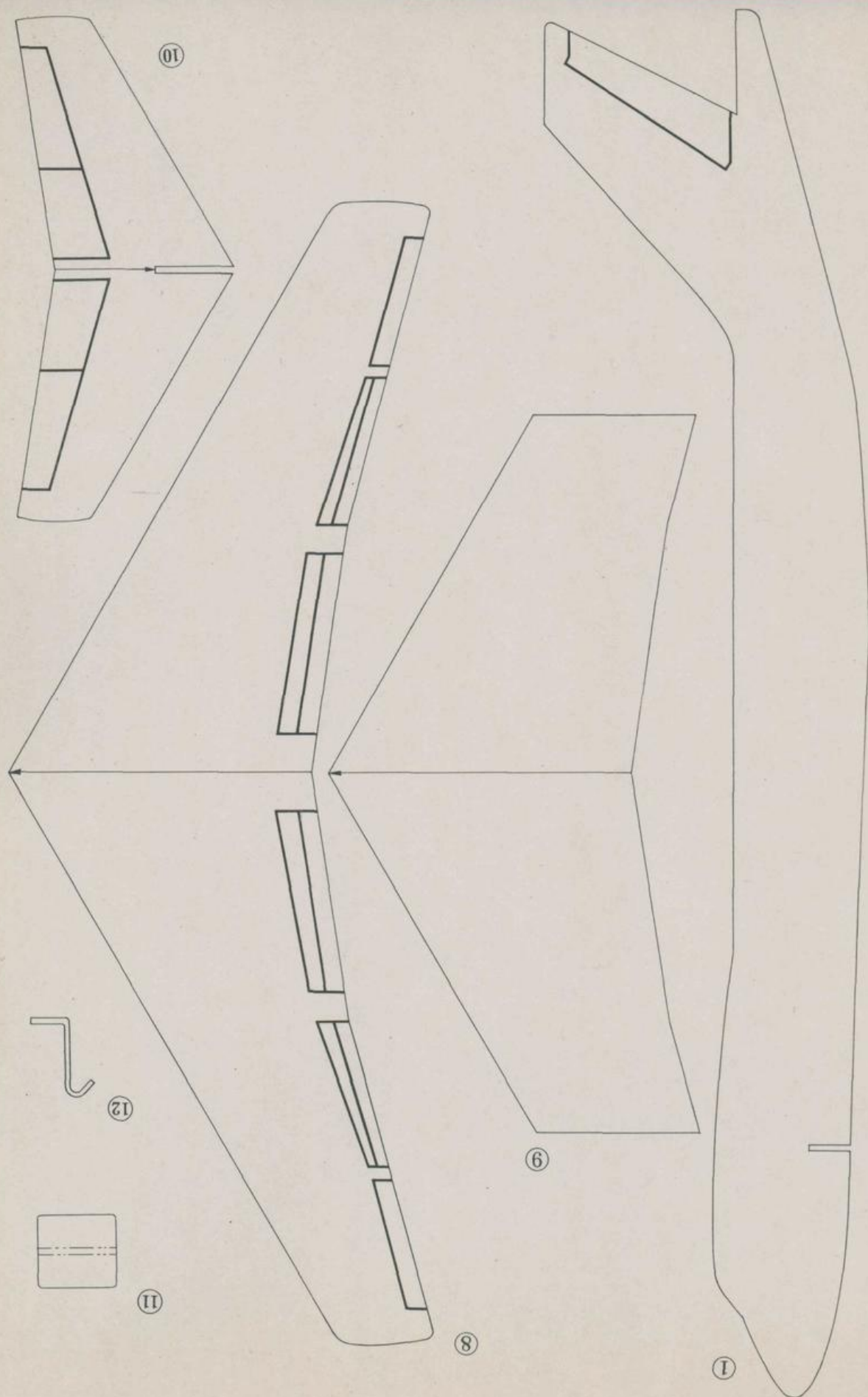
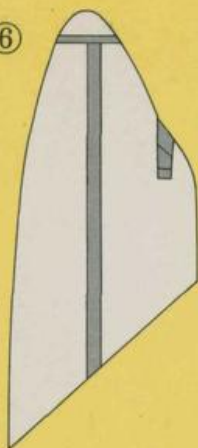
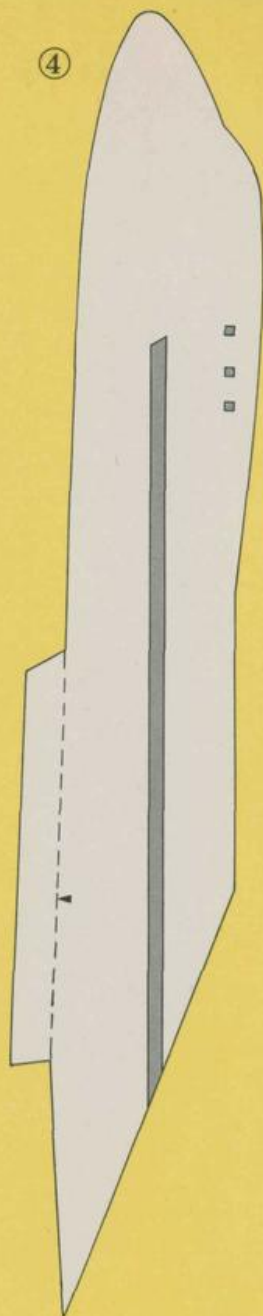
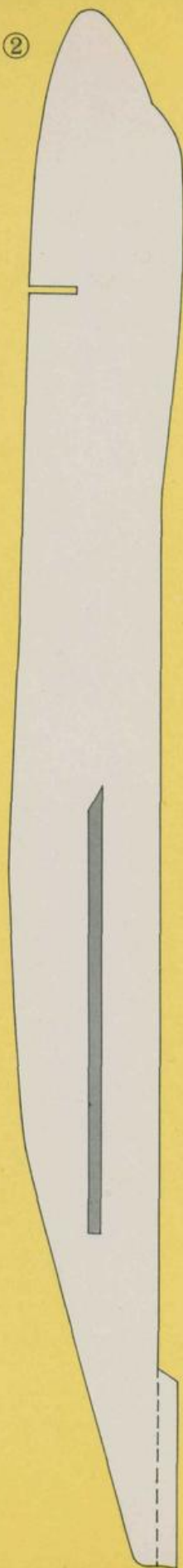
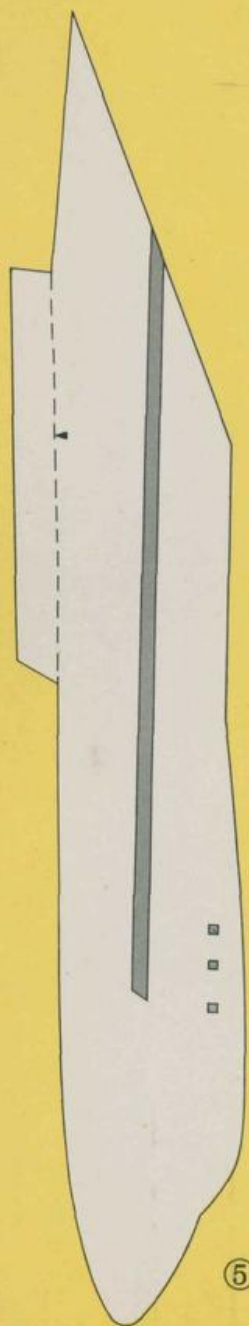
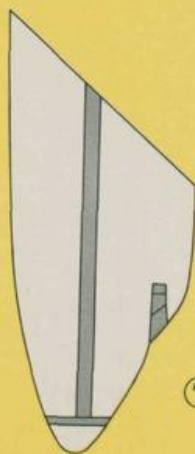
MAKING ADJUSTMENTS

Make adjustments only after the glue is completely dry. No additional weight is needed to align the center of gravity with the ▲ mark.

Round the wing surface only slightly with your fingers.

Dihedral angle of 5–10 degrees.

Straighten any bends in the fuselage or wing.

①
⑧
⑪
⑨
⑫
⑩

⑥
④
②
③
⑦
⑤

HAMBURGER HFB 320 "Hanza"

GLUING THE PARTS TOGETHER

Glue the horizontal tail-plane to the top of the vertical tail plane.

Glue the fuselage together in the order shown.

Bend a paper clip into the shape shown ⑭, and insert it into the bottom of the fuselage. Glue paper cover ⑮ over it.

Arrow mark faces front.

Bend the wing tips up.

Glue backing part ⑩ to part ⑨, and when this is dry glue it to the fuselage.

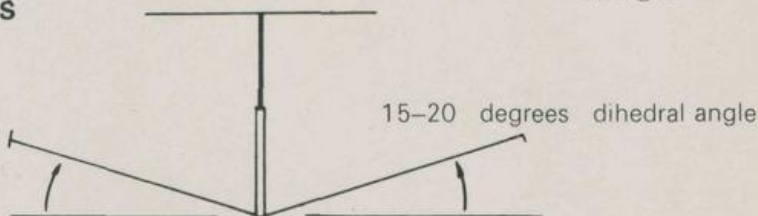
Bend the wing backing ⑩ ends down.

Glue wing parts ⑨ and ⑩ together. Then glue wing tips ⑪ on.

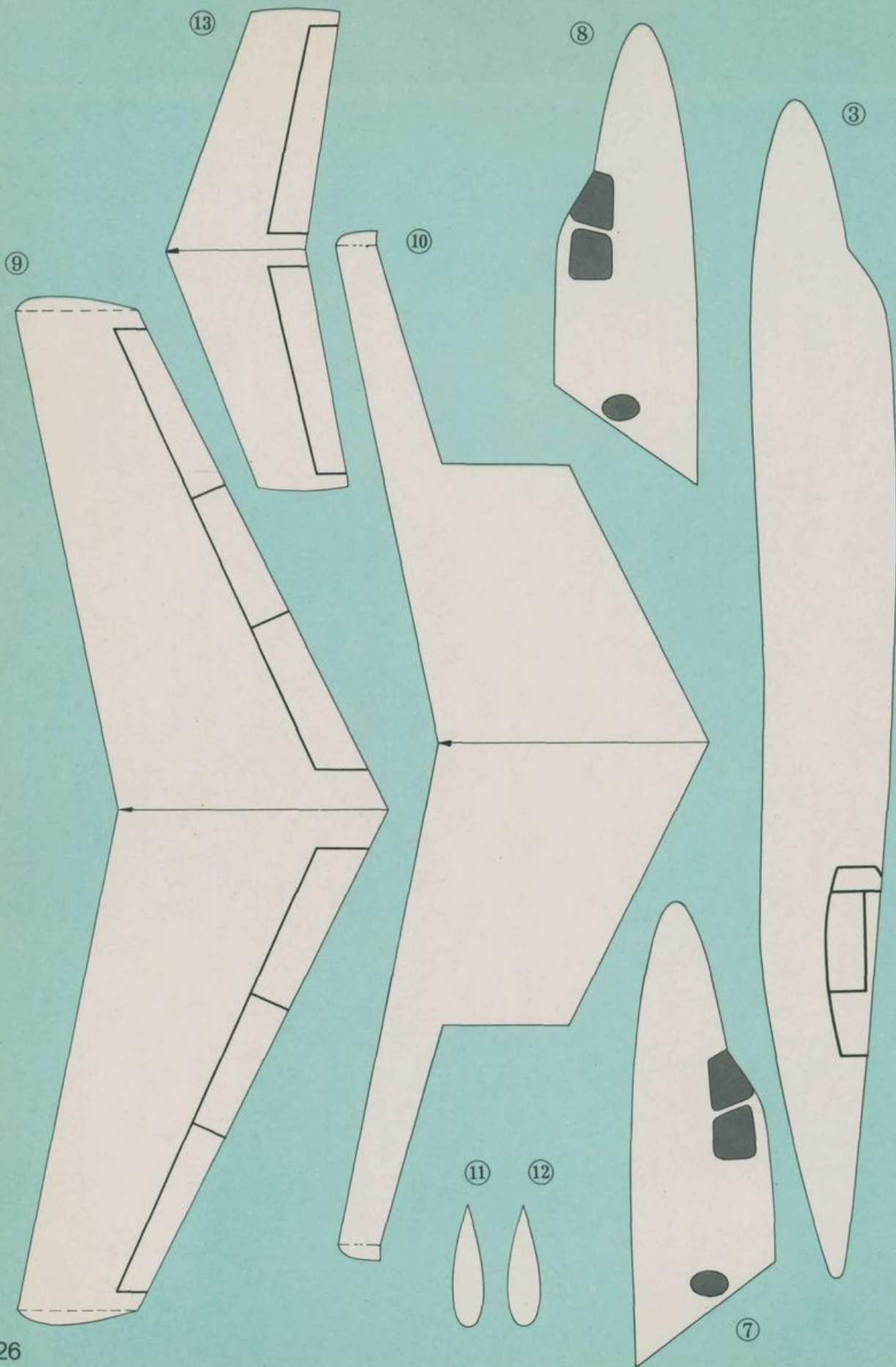
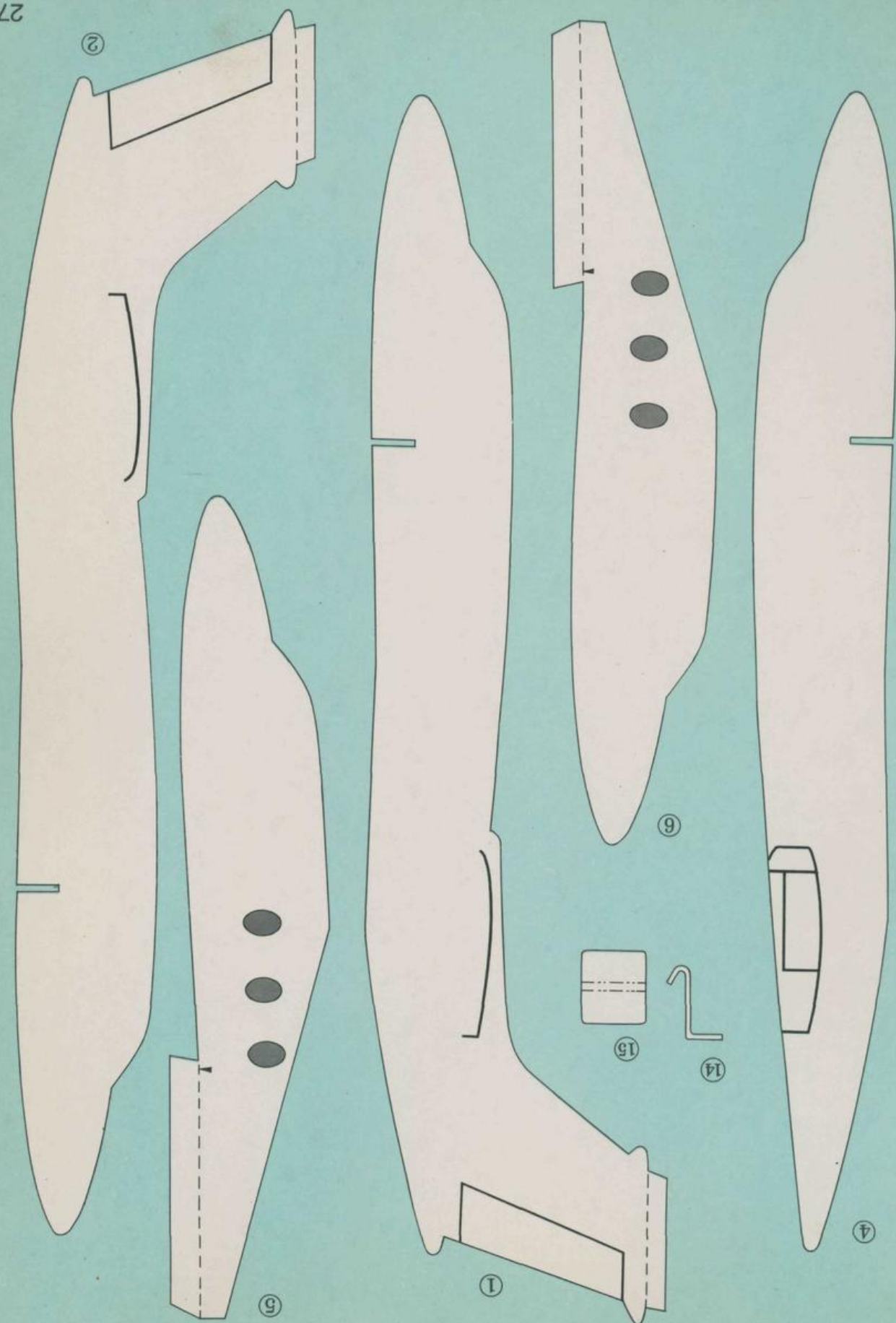
MAKING ADJUSTMENTS

The center of gravity in this model should align with the ▲ mark without extra weights.

Allow the model to dry completely before making any adjustments.

15–20 degrees dihedral angle

Straighten any bends in the fuselage, wings, or tail.

⑬
⑧
③
⑩
⑨
⑪
⑫
⑦

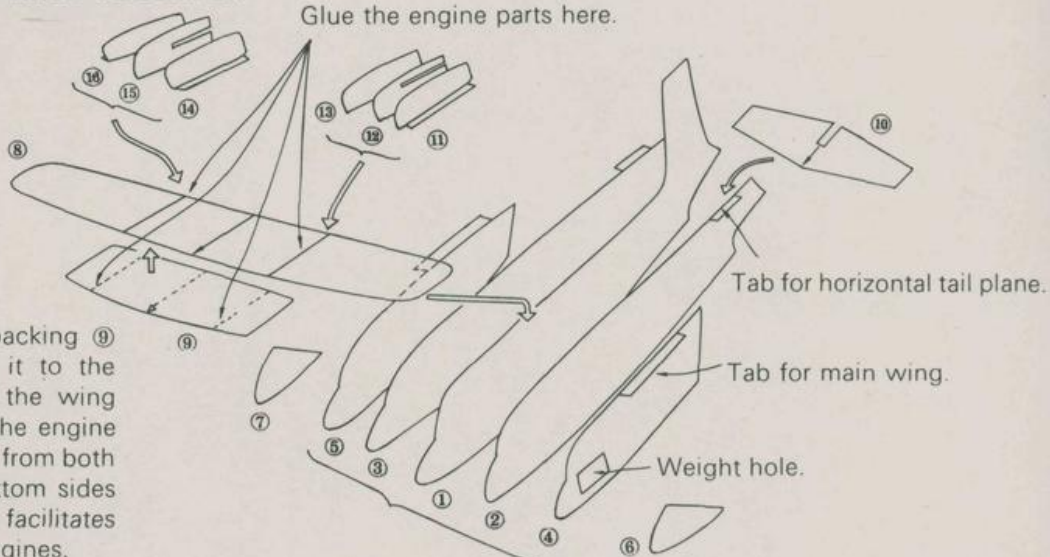
④
①
⑤
⑭
⑮
⑥
②

PIAGGIO P-136 L

GLUING THE PARTS TOGETHER

Glue the engine parts here.

Tab for horizontal tail plane.

Tab for main wing.

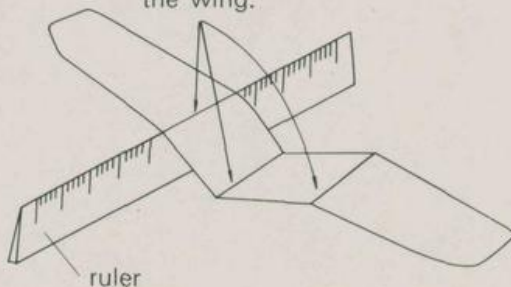
Weight hole.

Turn the wing backing ⑨ over, and glue it to the bottom side of the wing ⑧. By making the engine positions visible from both the top and bottom sides of the wing, this facilitates attaching the engines.

Glue the fuselage together in the order shown. Cut the weight hole after the fuselage dries.

Put the weight in the weight hole, and glue ⑥ and ⑦ on.

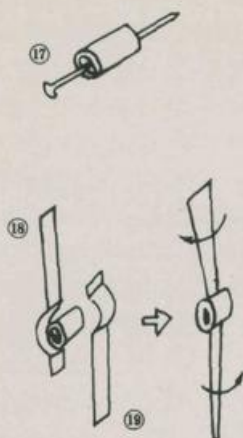
BENDING THE WING

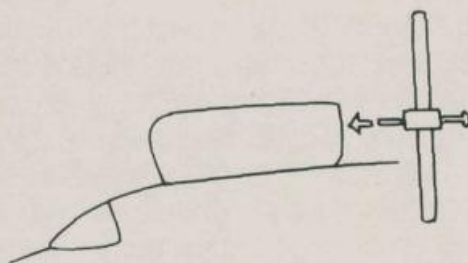
Glue the wing backing to the wing, and when it has dried bend the dihedral angle as shown below before attaching it to the fuselage.

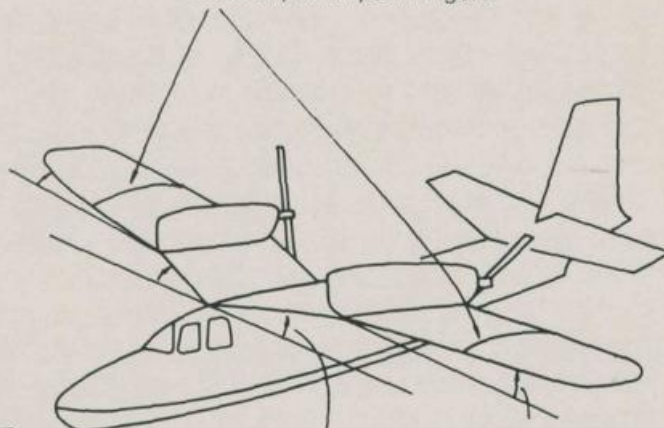
Hold a ruler along the lines, and carefully bend the wing.

MAKING THE PROPELLER

Make the propeller hub by putting glue on strip ⑰ and rolling it around a straight pin. The hub must revolve freely around the pin.

Glue the propeller blades (⑱ and ⑲) over the propeller hub as shown. When they are dry, twist the blades.

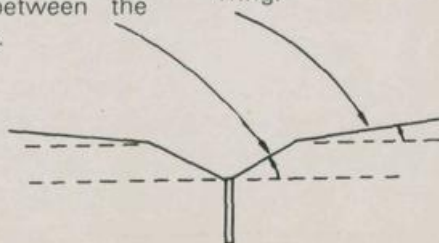
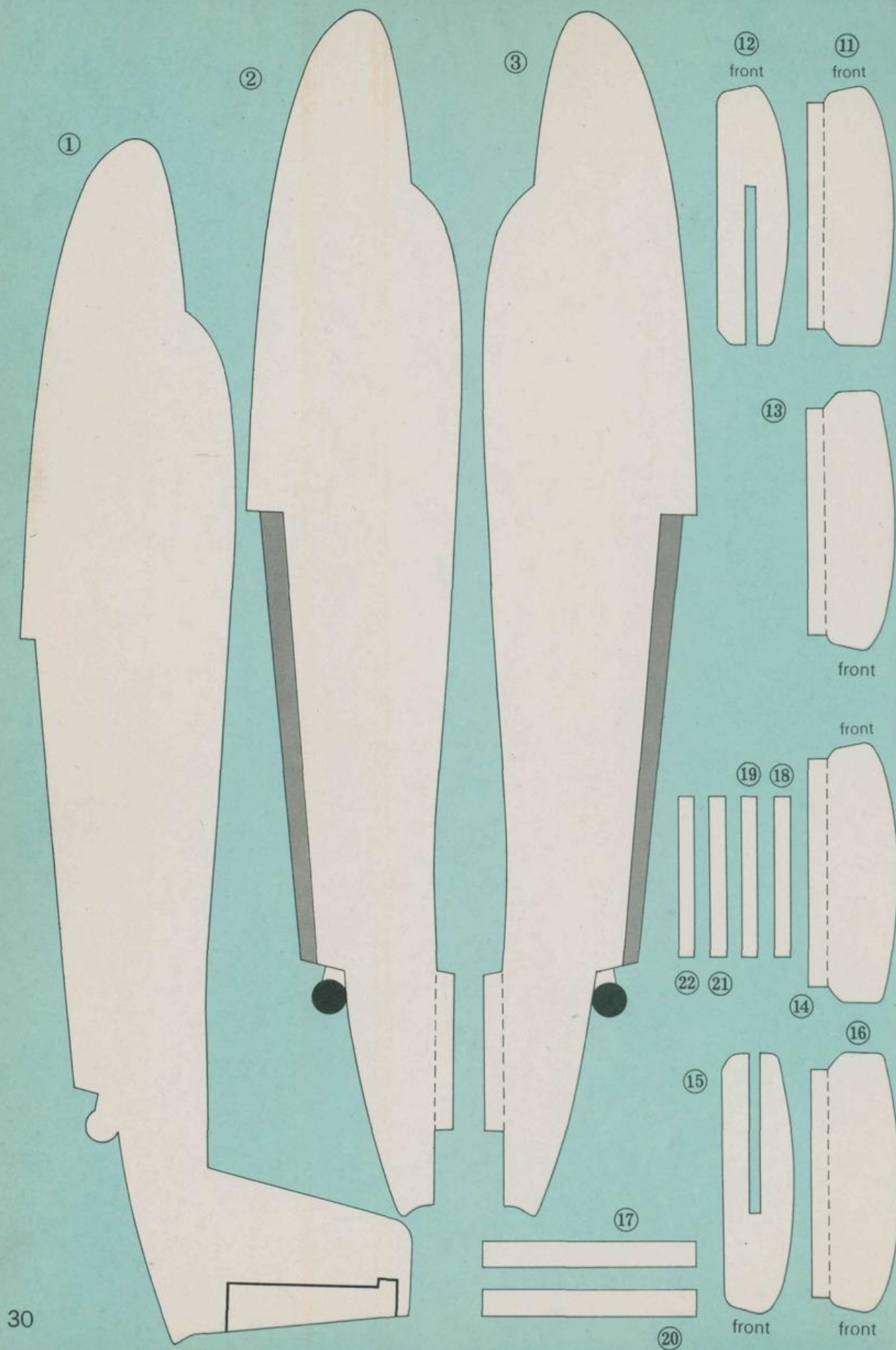
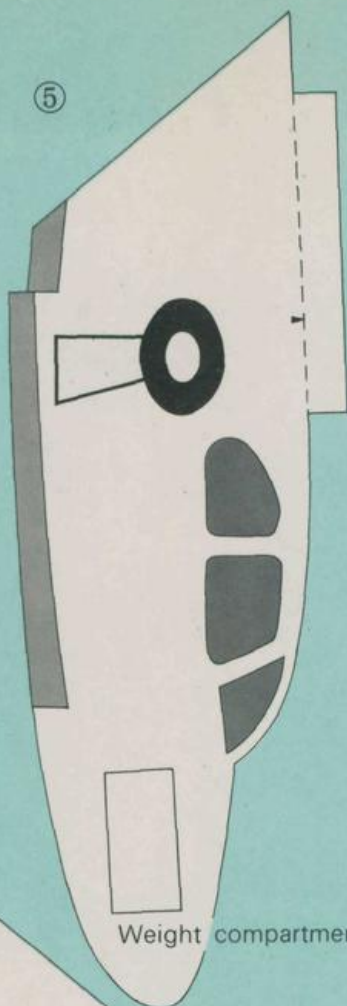
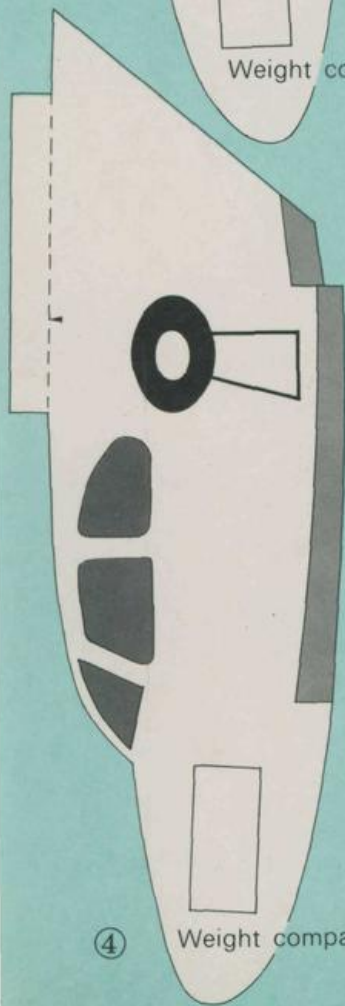
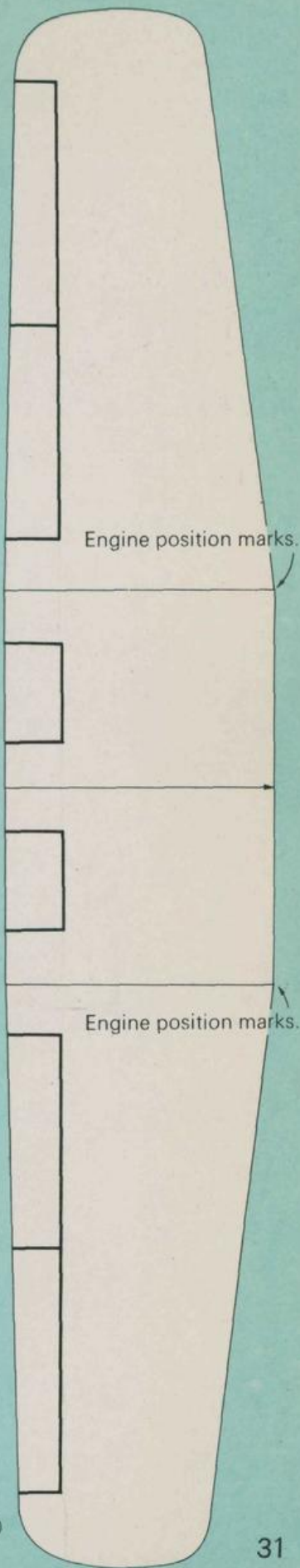
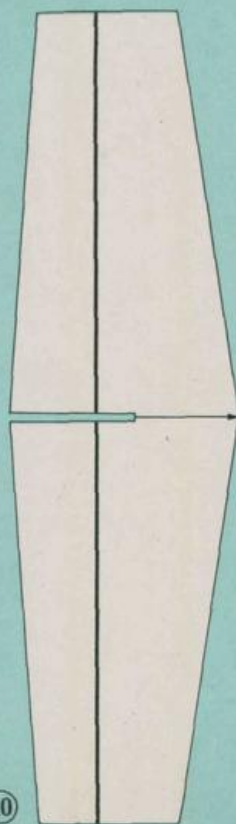
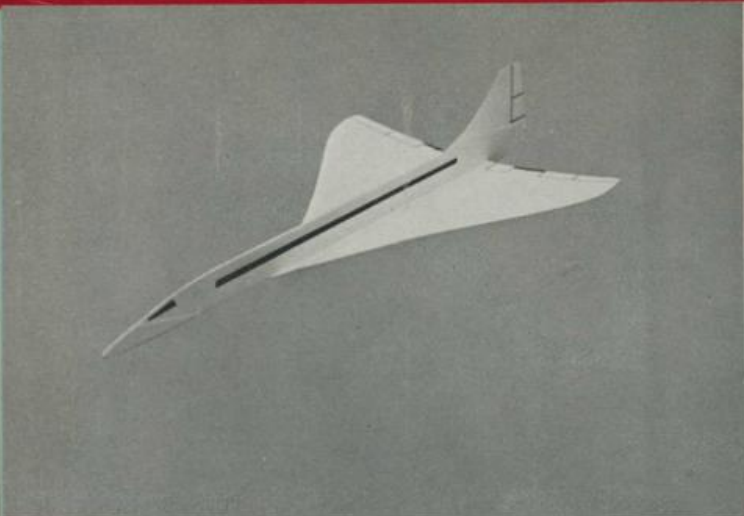
Push a straight pin through the hub and into the rear of the engine. Trim the blades till they balance.
Another propeller can be made with parts ⑳, ㉑, and ㉒

ADDING THE WEIGHTS

After the fuselage parts (① thru ⑤) are glued together and the wing and tail glued on and when plane is completely dry, add lead foil or weights to the weight hole. Align the center of gravity with the ▲ mark. But remember to add the weight of the weight hole covers (⑥–⑦) to the total to prevent the nose from being too heavy. When you have inserted the proper amount of weight glue the covers on both sides. These instruction apply to all models with weight holes.

MAKING ADJUSTMENTS

Round the wing surface carefully with your fingers.

Straighten any bends in the fuselage or wing.

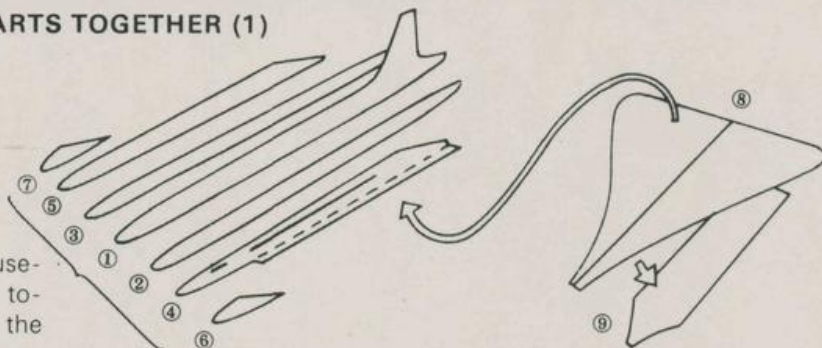
A 10–15 degrees dihedral angle in the wing between the engines.

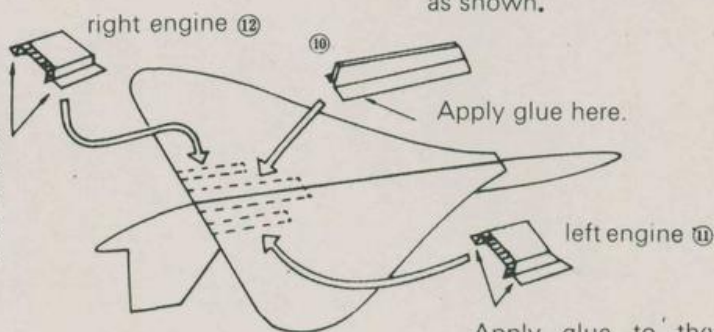
A 5 degrees dihedral angle in the outer wing.

①
②
③
⑫
front
⑪
front
⑬
front
front
⑲ ⑱
㉒ ㉑
⑭
⑯
⑮
⑰
front
front
⑳

⑤
⑨
Engine position marks.
Engine position marks.
Engine position marks.
Weight compartment.
Engine position marks.
⑥
⑦
④
Weight compartment.
⑩
⑧

INTERNATIONAL "Concord"

Glue the wing backing ⑨ to the wing, and then glue the wing to the fuselage. When doing this turn the wing backing ⑨ over so that the engine position marks will appear on the bottom surface after gluing.

GLUING THE PARTS TOGETHER (1)

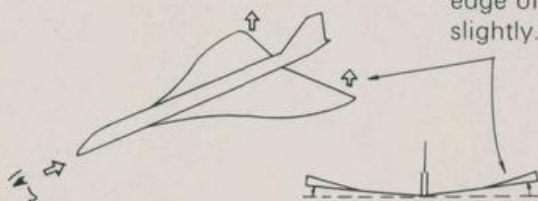
Glue the fuselage parts together in the order shown.

GLUING THE PARTS TOGETHER (2)

This diagram shows the model upside-down.

Fold the handle ⑩ on the lines and then glue it to the bottom surface of the wing as shown.

Apply glue to the engine tabs and align them with the engine position marks.

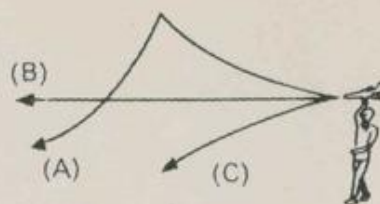
Apply glue to the engine tabs and align them with the engine position marks.

MAKING ADJUSTMENTS

Make adjustments only after the glue is completely dry. The center of gravity in this model can be adjusted to the ▲ mark without adding weights.

Bend the trailing edge of the wing up slightly.

Straighten any bends in the fuselage or wing.

dihedral angle of from 0–5 degrees

Grasp the handle ⑩ and throw the plane. Aim the plane toward a curtain or other soft object to avoid damaging the nose.

Throw the model gently toward the horizon, and make necessary adjustments.

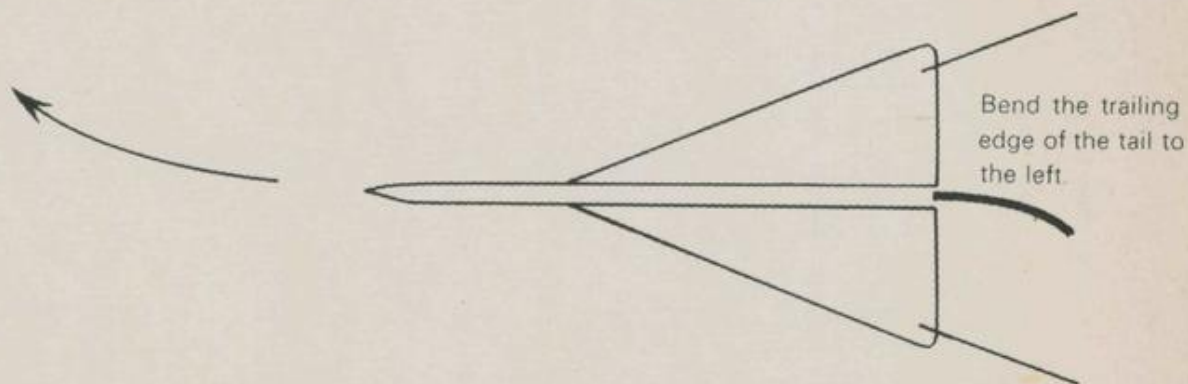
(A) Bend the trailing edge of the delta wing down slightly.

(B) No adjustment necessary.

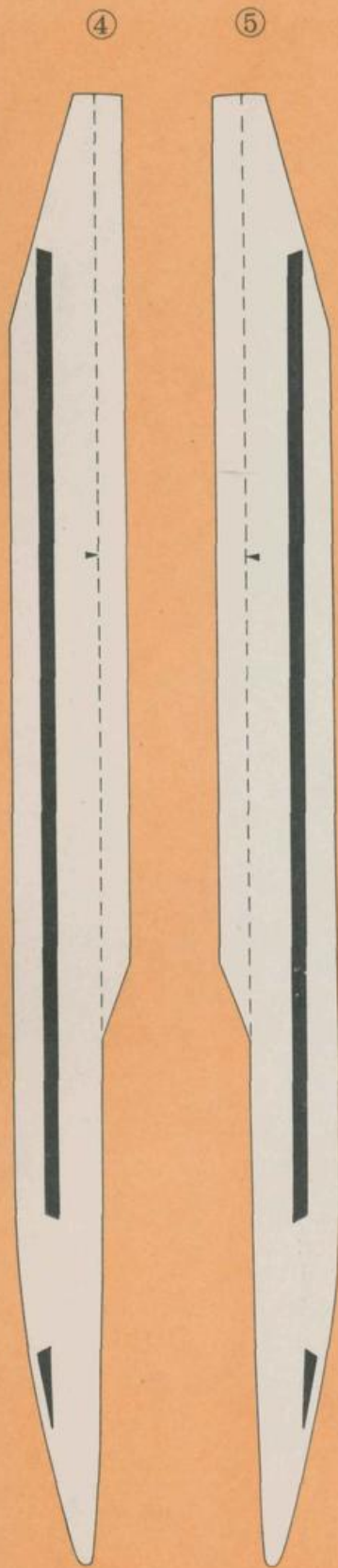
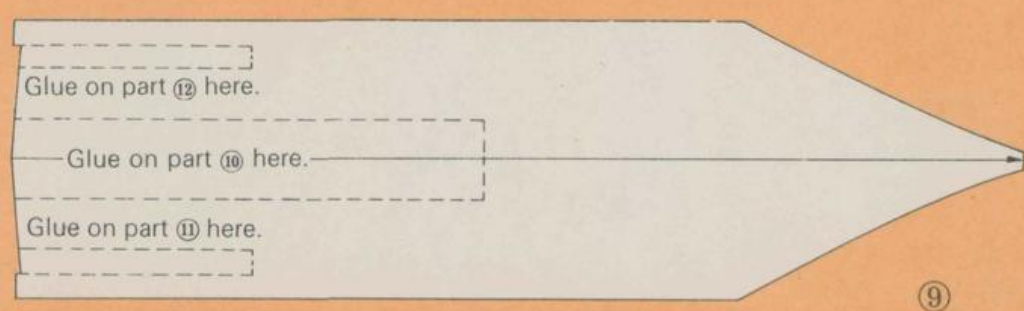
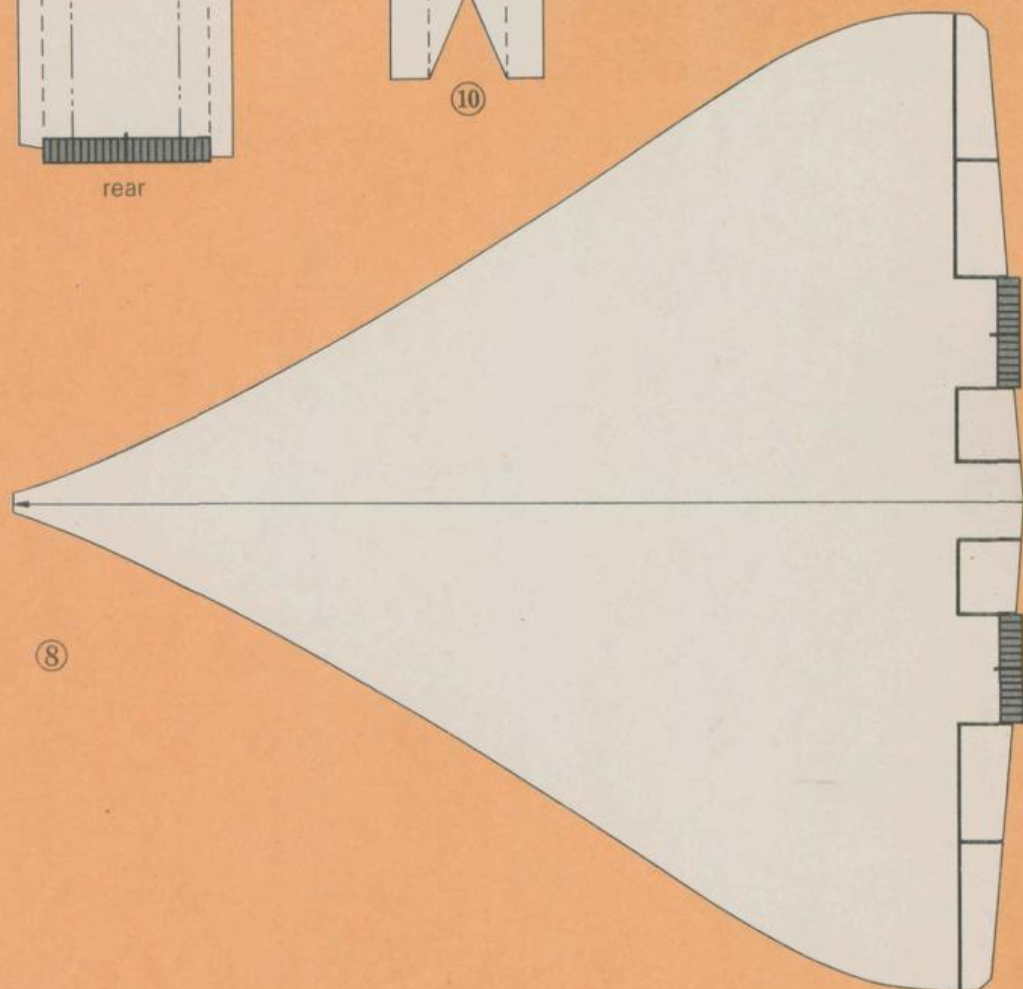
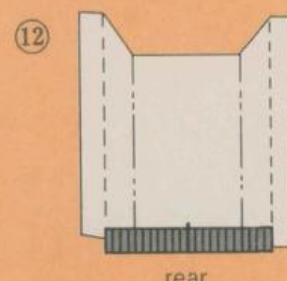
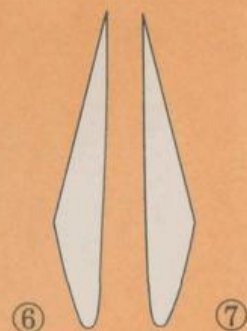
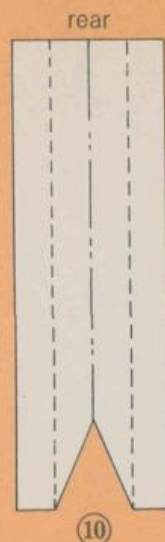
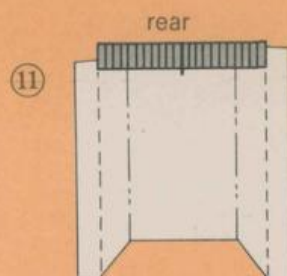
(C) Bend the trailing edge of the delta wing up slightly.

If the model goes into right turns make the following adjustments: (For left turns simply reverse the directions.)

Bend the trailing edge of the right wing up only slightly.

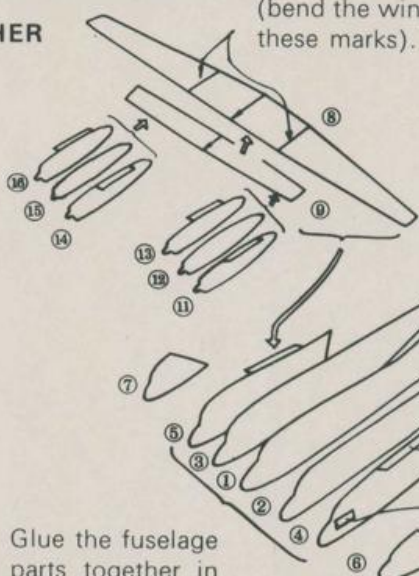
Bend the trailing edge of the tail to the left.

Bend the trailing edge of the left wing up fairly high.

④
⑤
②
③
①

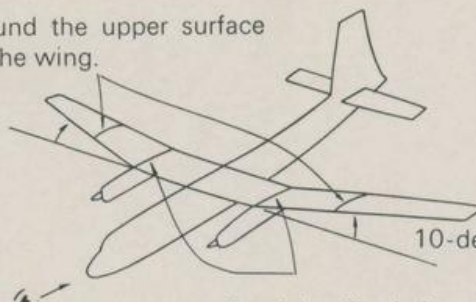
rear
⑪
rear
⑫
rear
⑩
⑥
⑦
⑧
Glue on part ⑫ here.
Glue on part ⑩ here.
Glue on part ⑪ here.
⑨

FAIRCHILD-HILLER FH-227

GLUING THE PARTS TOGETHER

Glue the wing backing ⑨ to the bottom surface of the wing ⑧.

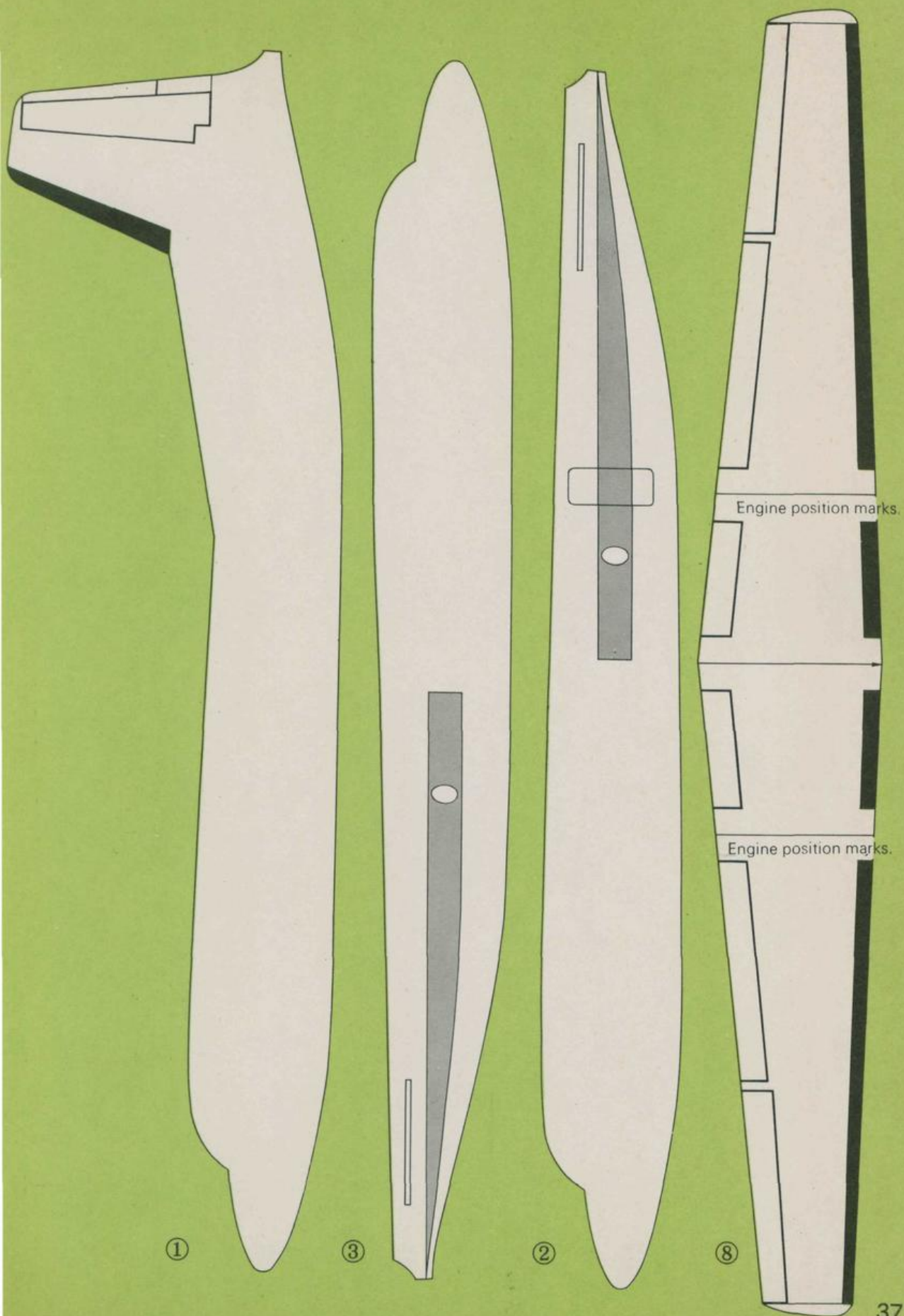
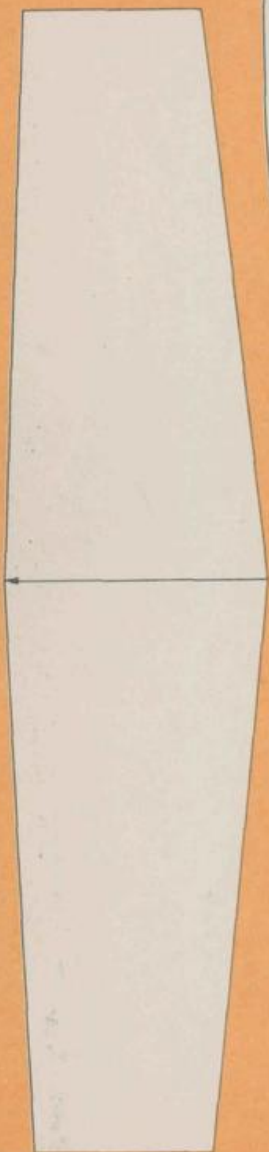
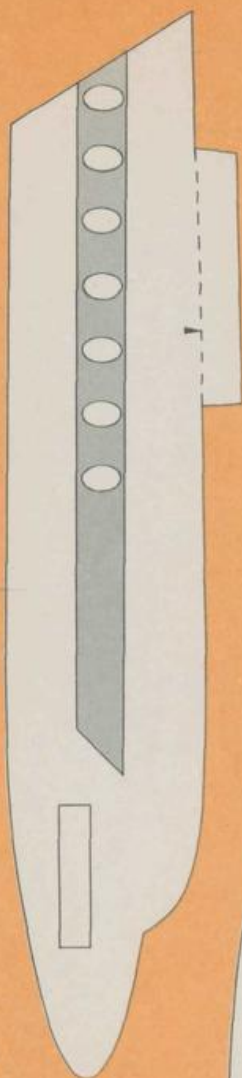
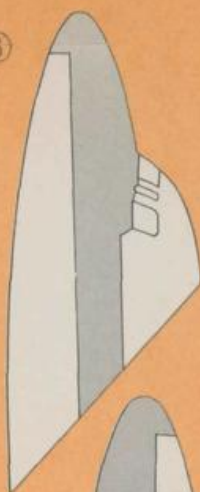
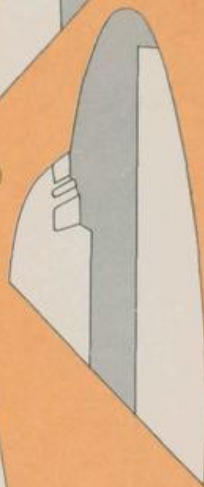
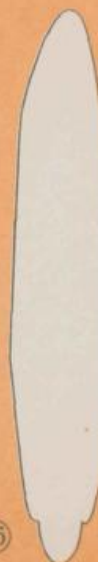
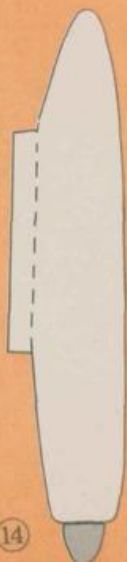
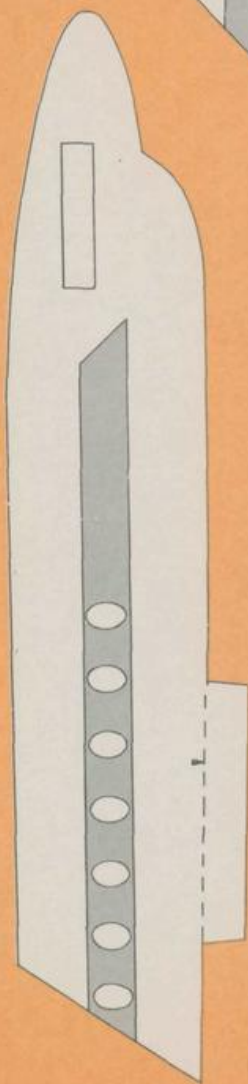
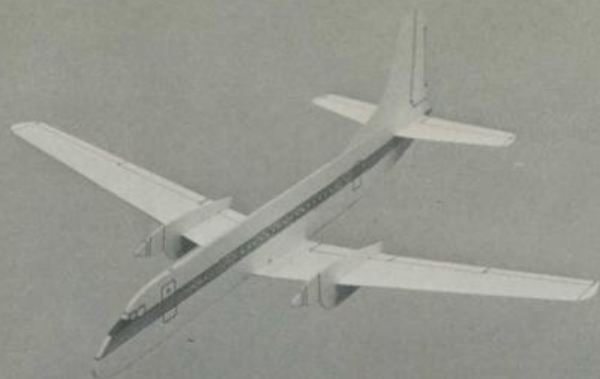
Glue parts ⑪, ⑫, and ⑬ together to make one engine and parts ⑭, ⑮, and ⑯ for the other. Glue the completed engines to the bottom surface of the wing after aligning them with the engine position marks on the upper surface of the wing.

Glue the fuselage parts together in the order shown, and when they are completely dry, cut the weight hole in the nose.

Next attach the wing and the tail to the fuselage, insert the weight in the weight hole, and align the center of gravity with the ▲ mark. Finally, glue on weight hole covers ⑥ and ⑦.

MAKING ADJUSTMENTS

Look down the nose of the plane, and carefully straighten any bends in the fuselage, wing, or engines.

Bend the dihedral angle in from this line.

Engine position marks.
Engine position marks.
①
③
②
⑧

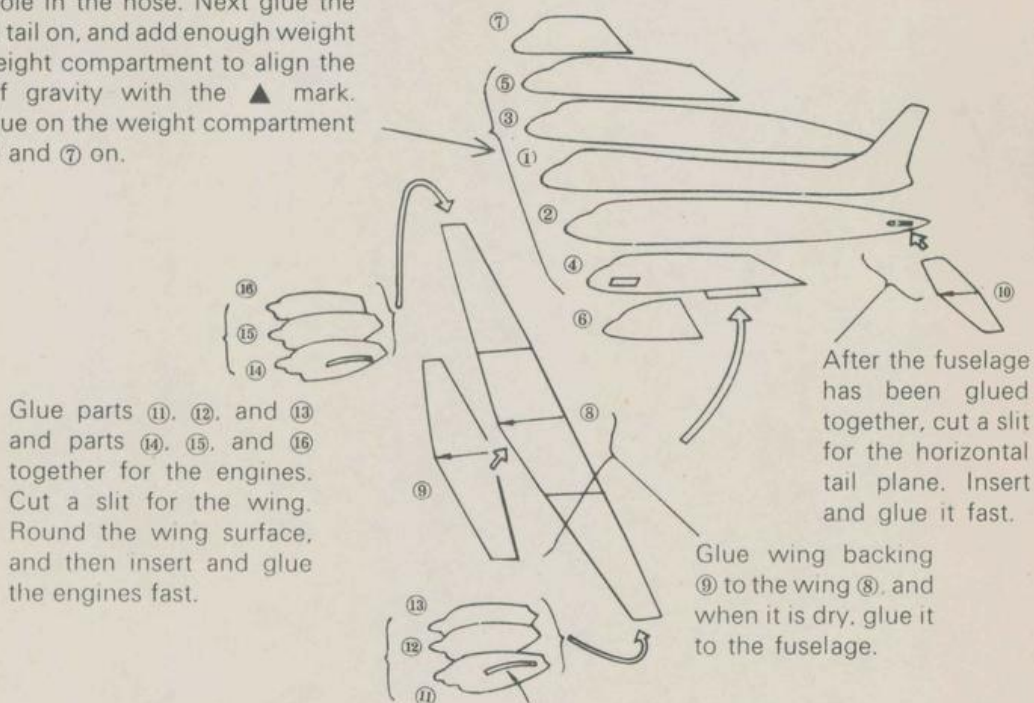
④
⑤
⑥
⑦
⑨
⑩
⑪
⑫
⑬
⑭
⑮
⑯

NAMC YS-11

GLUING THE PARTS TOGETHER

Glue the fuselage parts together in the order shown, and when it is dry cut a weight hole in the nose. Next glue the wing and tail on, and add enough weight to the weight compartment to align the center of gravity with the ▲ mark. Finally glue on the weight compartment covers ⑥ and ⑦ on.

After the fuselage has been glued together, cut a slit for the horizontal tail plane. Insert and glue it fast.

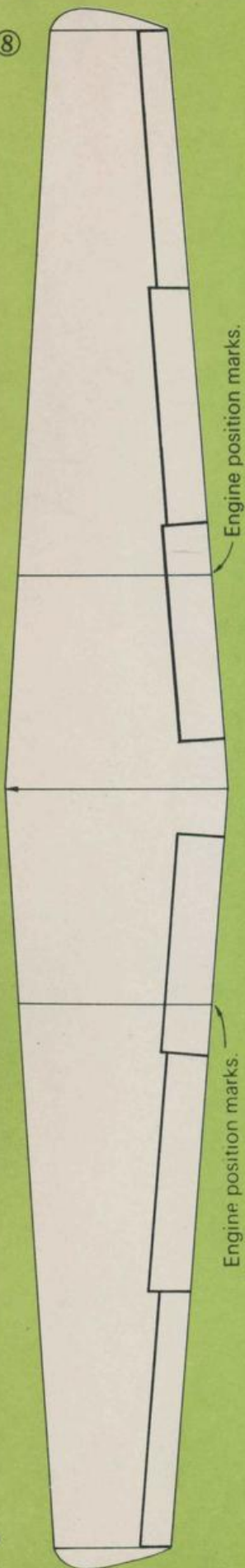
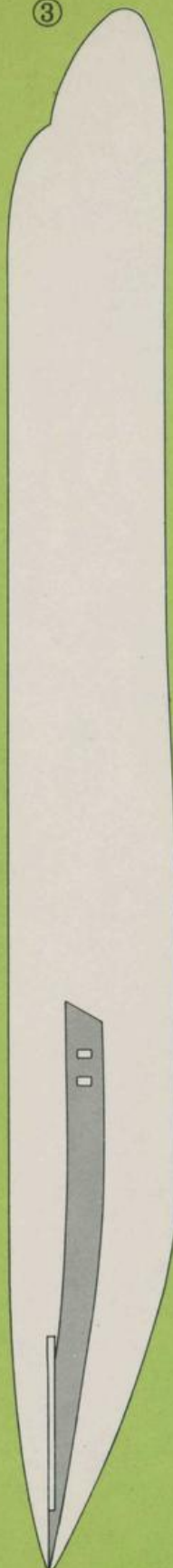
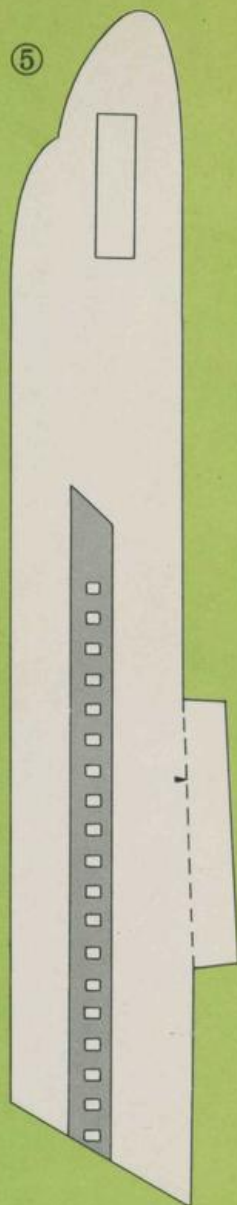
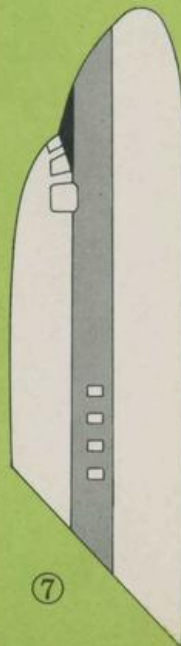
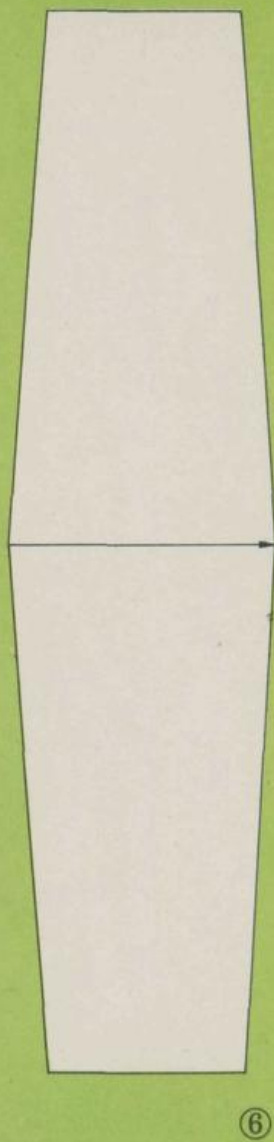
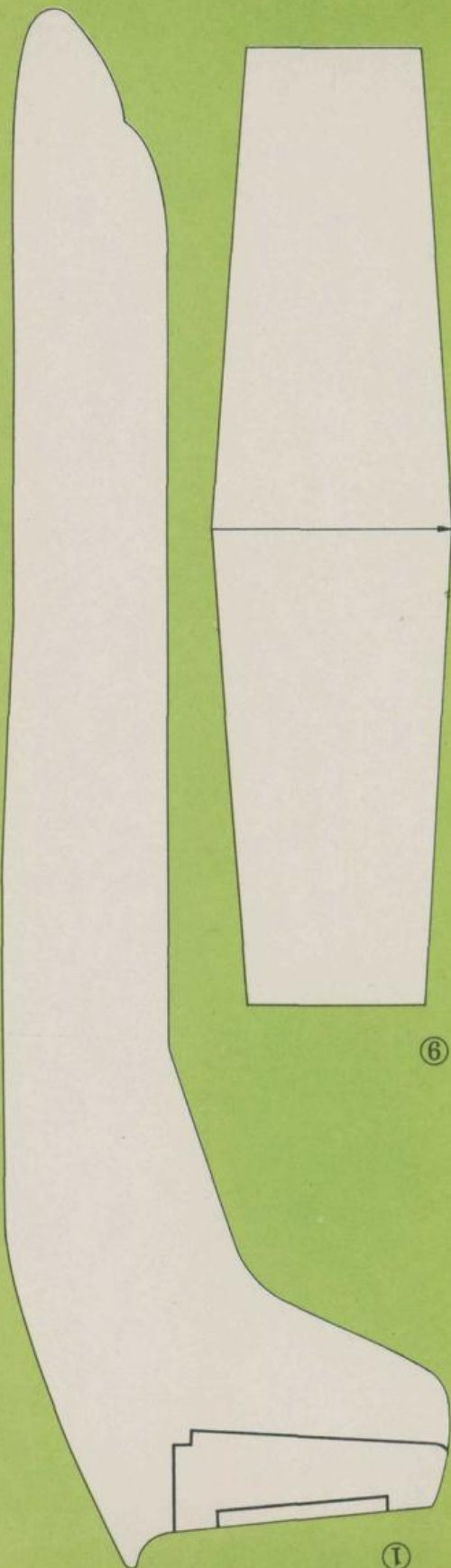
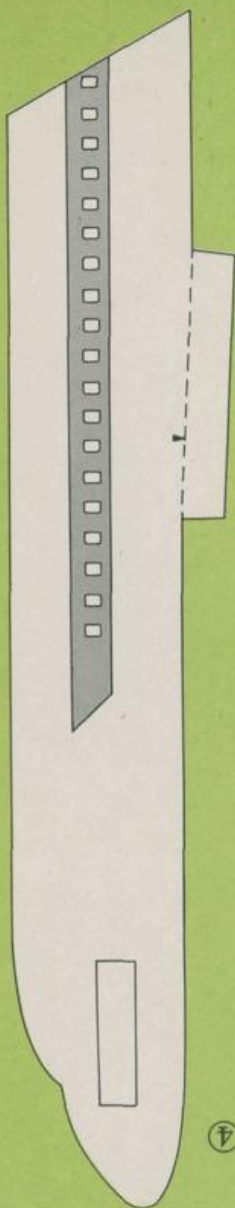
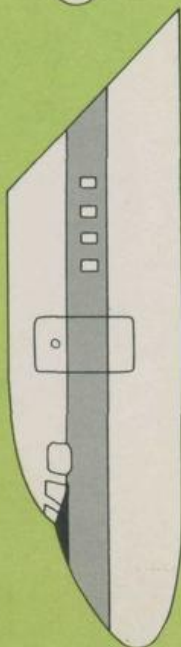
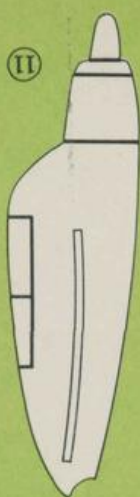
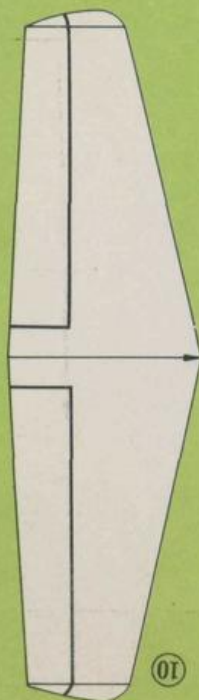
Glue parts ⑪, ⑫, and ⑬ and parts ⑭, ⑮, and ⑯ together for the engines. Cut a slit for the wing. Round the wing surface, and then insert and glue the engines fast.

Glue wing backing ⑨ to the wing ⑧, and when it is dry, glue it to the fuselage.

MAKING ADJUSTMENTS

Round the wing surface before inserting the engines.

Look down the front of the plane, and straighten any bends in the fuselage, wing, or engines.

Dihedral angle of from 10-15 degrees.

⑧
②
③
⑤
Engine position marks.
Engine position marks.
⑦

①
⑥
⑩
⑯
⑨
④
⑮
⑫
⑭
⑪
⑬

BEAGLE 121 "Pup"

Glue the fuselage together, and cut a slit for the horizontal tail plane. Insert and glue it fast.

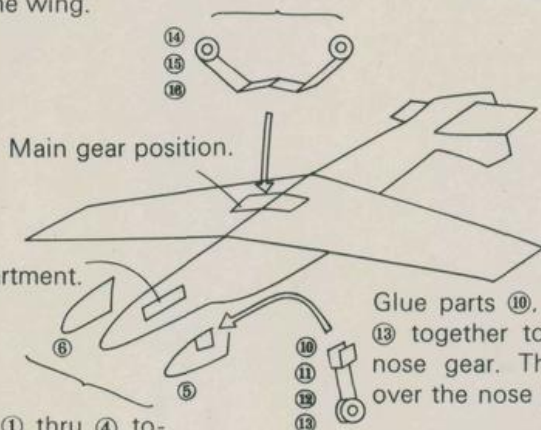
GLUING THE PARTS TOGETHER (1)

Glue the fuselage parts together in the order shown. Then cut a weight compartment with a knife.

Glue the wing (⑦ and ⑧) here.

Weight compartment.

GLUING THE PARTS TOGETHER (2)

Glue parts ⑭, ⑮, and ⑯ together to make the main gear, and glue it in position on the bottom surface of the wing.

Glue part ⑧ to the back of part ⑦. When doing this, turn ⑧ over so that the main gear position will be visible.

Main gear position.

Weight compartment.

Glue parts ⑩, ⑪, ⑫, and ⑬ together to make the nose gear. Then glue it over the nose pieces.

Glue parts ① thru ④ together to make the fuselage. Cut a compartment for the weight. Next attach the wing and tail, and then add enough weight to align the center of gravity with the ▲ mark.

Then glue parts ⑤ and ⑥ on.

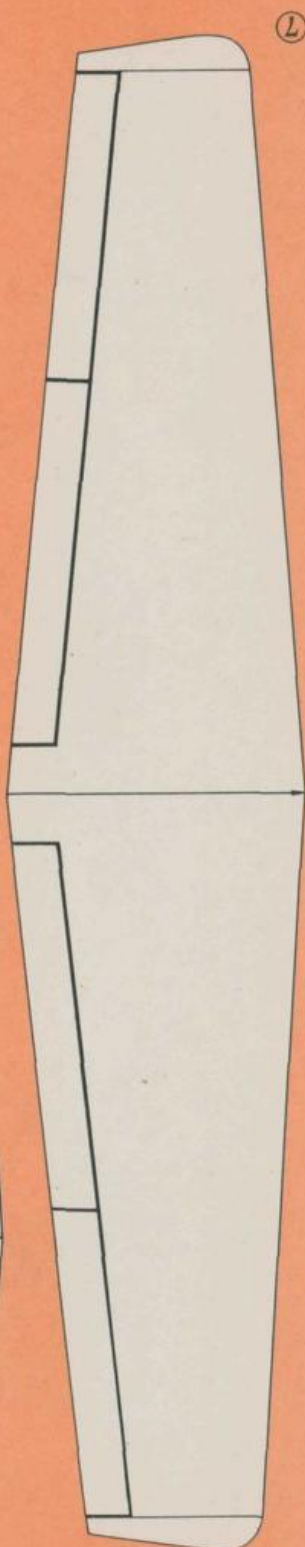
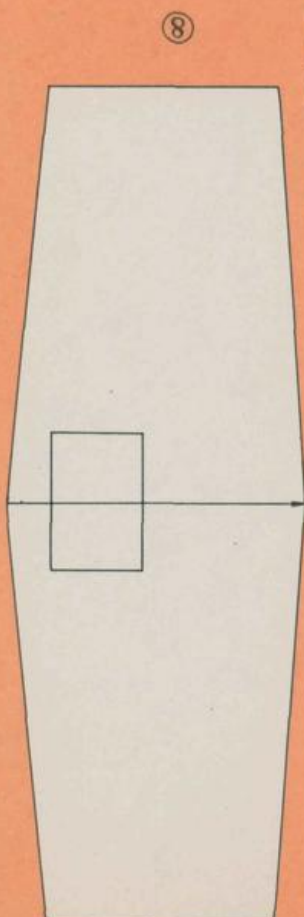
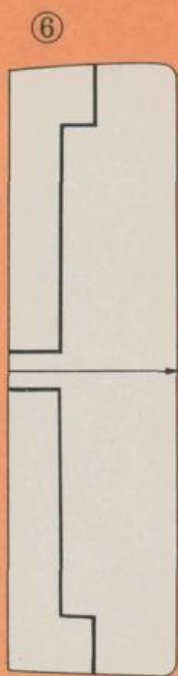
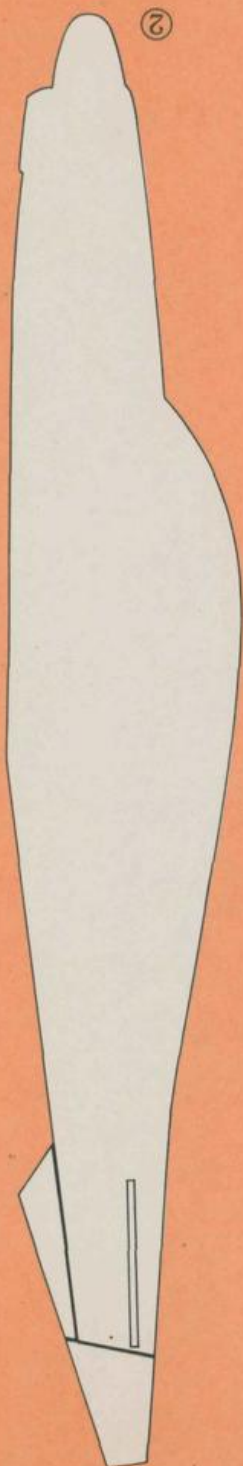
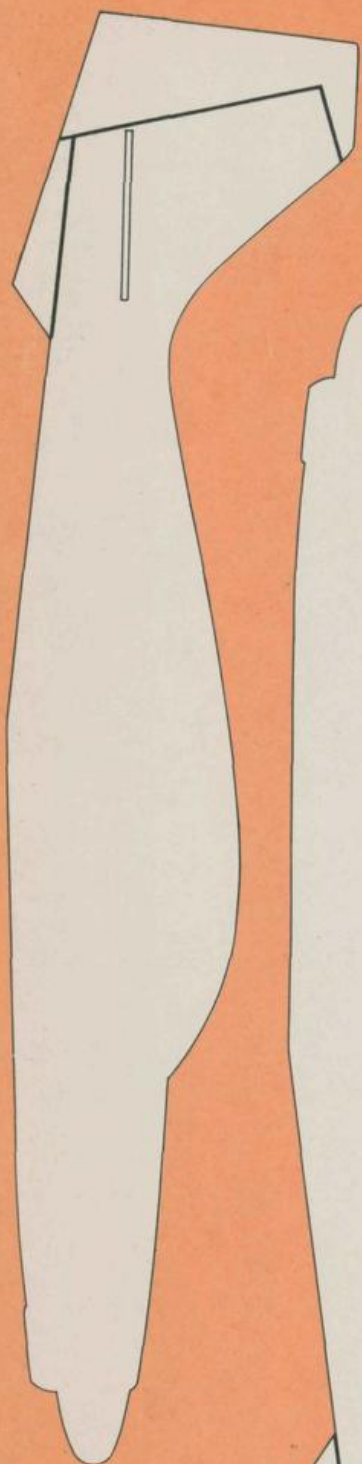
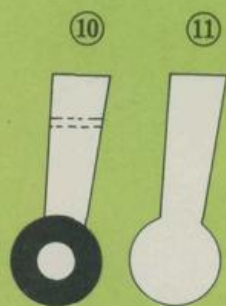
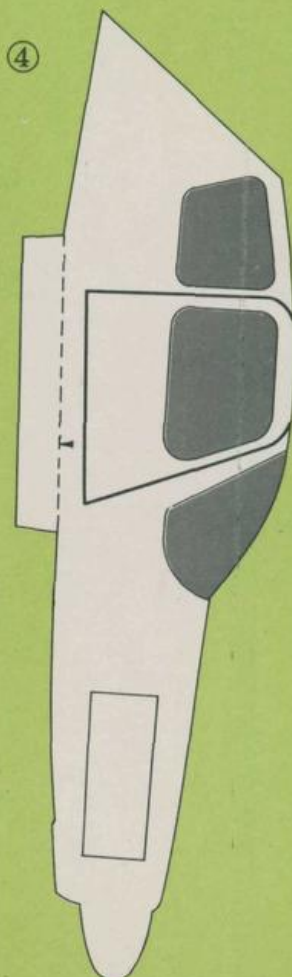
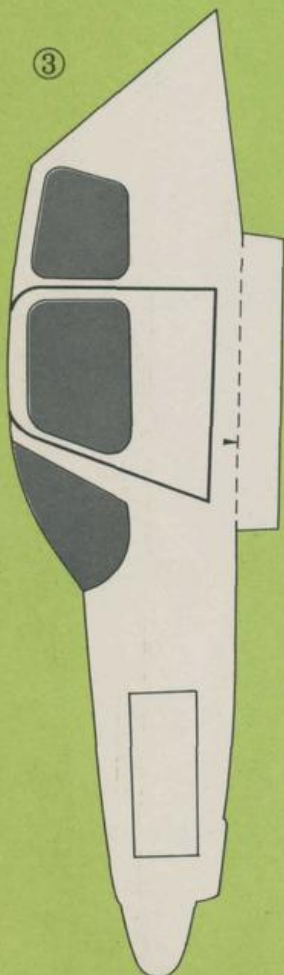
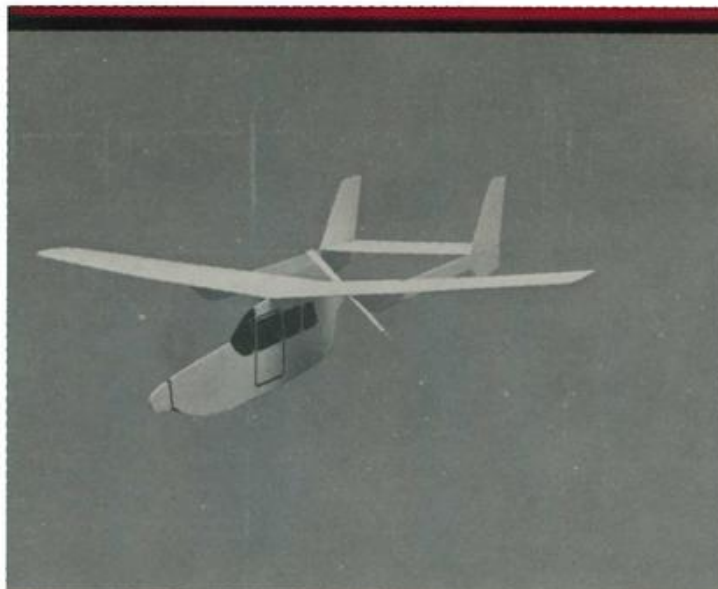
MAKING ADJUSTMENTS

Round the surface of the wing.

Look down the nose of the plane, and straighten any bends in the fuselage or wing.

Dihedral angle of from 10-15 degrees.

⑧
②
⑦
⑨
①

⑭
⑮
⑯
⑥
Glue nose gear here.
Glue nose gear here.
⑤
③
④
⑩
⑪
⑫
⑬

CESSNA 336
"Skymaster"

Both rear fuselages are attached here. (The wing dihedral angle is added here also.)

Glue together.

⑬

⑭

GLUING THE PARTS TOGETHER (1)

Glue the forward nacelle and rear fuselages to the wing.

⑫ ⑪ ⑩

Glue together.

⑮

Glue the horizontal tail plane here.

④ ② ① ③

Glue together in the order shown. When it is dry, cut a weight compartment.

⑨ ⑧ ⑦

Glue together.

GLUING THE PARTS TOGETHER (2)

After attaching the tail and wing to the fuselage, put a weight in the weight compartment in the nose, and align the center of gravity with the ▲ mark. Then glue parts ⑤ and ⑥ to the nose.

Make the propeller with parts ⑯, ⑰, and ⑱ (See page 29 for propeller construction method.) Put a pin thru the propeller hub, and insert the pin into the trailing edge of the fuselage.

MAKING ADJUSTMENTS

Look down the nose, and straighten any bends in the fuselage or wing.

⑯
⑰
⑱
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⑮
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⑬
⑭

③
⑧
Glue horizontal
stabilizer here.
⑨
⑦
⑫
②
⑥
Glue horizontal
stabilizer here.
⑩
⑪
⑤

BOEING 727

GLUING THE PARTS TOGETHER

When gluing fuselage parts ① and ② together, insert the bottom half of the top edge of the vertical stabilizer ⑨ between the two sections as shown.

Glue the horizontal tail plane here.

Glue the fuselage parts together in the order shown.

Bend a paper clip into the shape shown in ⑬, and insert it into the nose. Glue a paper cover ⑭ over it to keep it in place.

Glue wing backing ⑪ to the wing ⑩ and then to the fuselage.

MAKING ADJUSTMENTS

The center of gravity in this model should align with the ▲ mark without additional any weights.

Round the wing surface carefully with your fingers.

Dihedral angle of 5–10 degrees.

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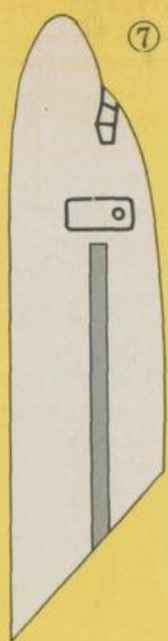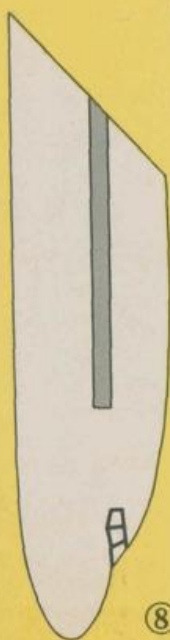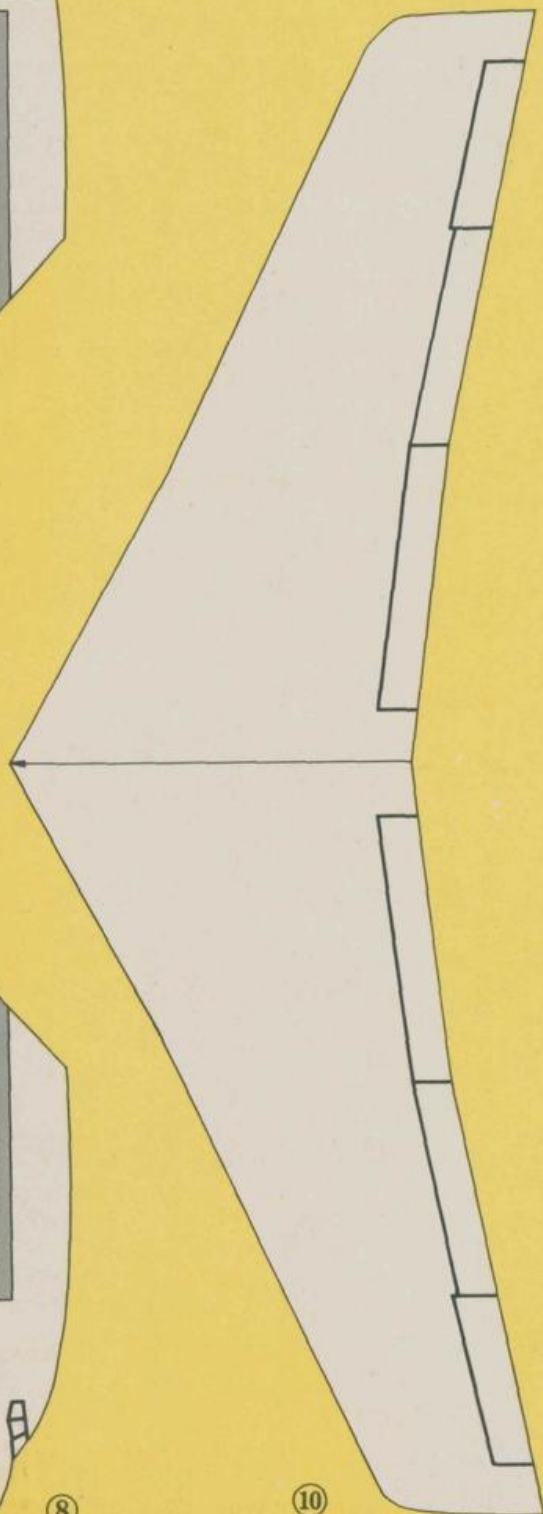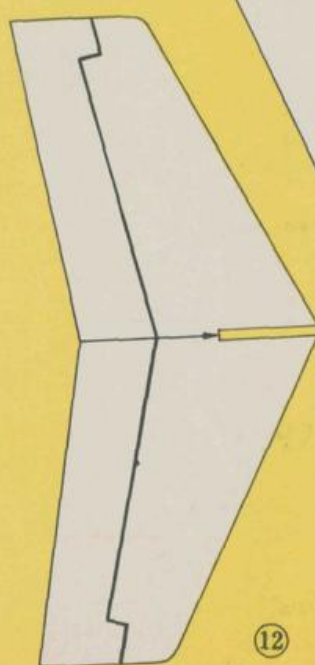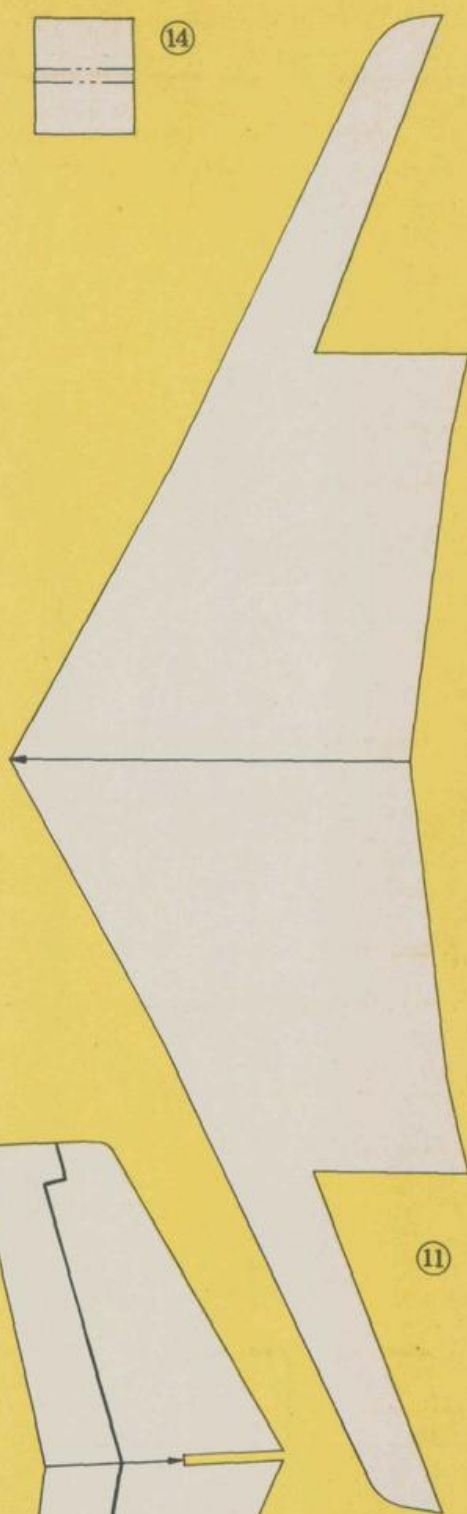
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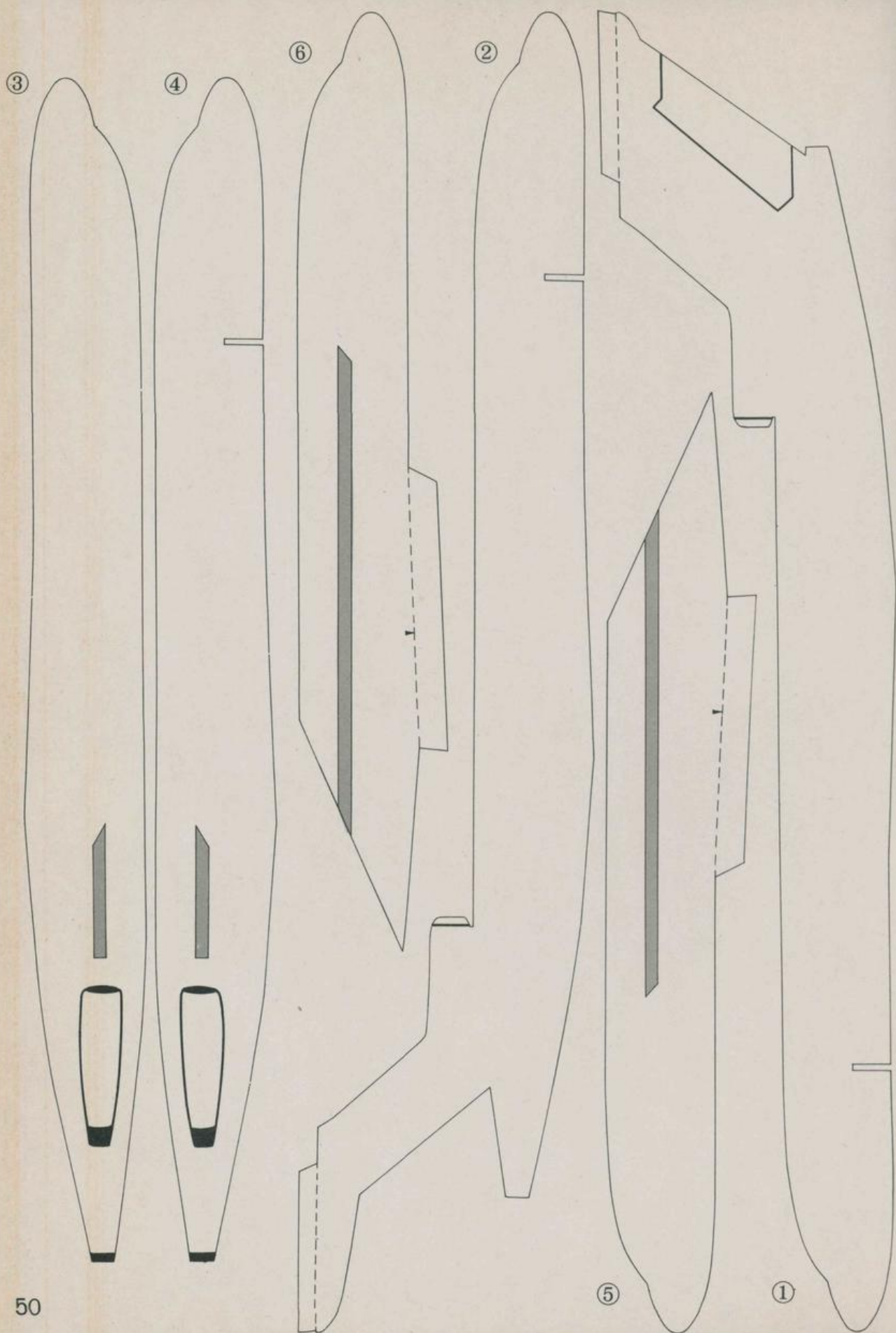
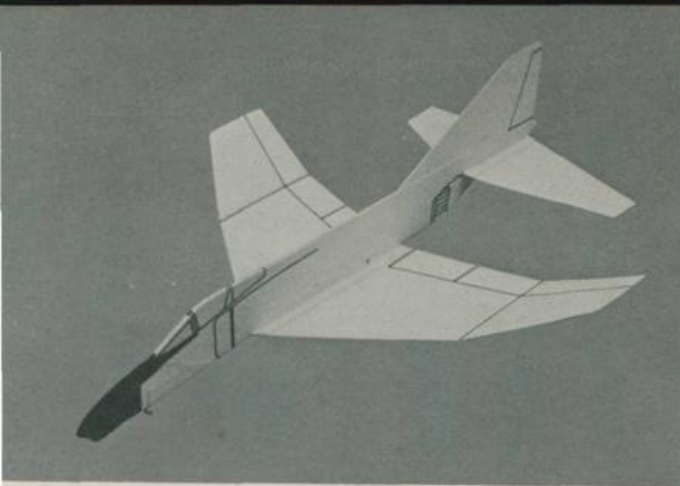

McDONNELL-DOUGLAS F-4 "Phantom II"

Bend the tail down from the center line, and glue it to the tab.

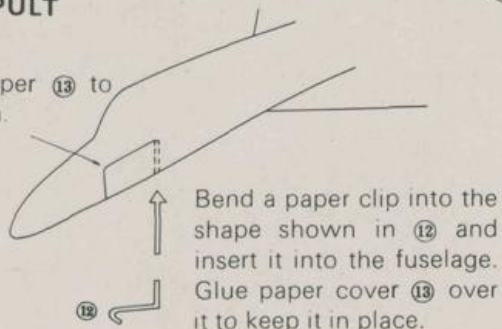
GLUING THE PARTS TOGETHER

Glue the fuselage parts together in the order shown.

Glue the wing backing ⑩ to the bottom surface of the wing ⑨, and when it is dry, glue it to the fuselage.

ATTACHING A HOOK FOR A RUBBER CATAPULT

Glue paper ⑬ to this area.

Bend a paper clip into the shape shown in ⑫ and insert it into the fuselage. Glue paper cover ⑬ over it to keep it in place.

MAKING ADJUSTMENTS

Allow the modol to dry for from five to six hours before making any adjustments. The center of gravity in this model should align with the ▲ mark without additional any weights.

Bend the wing dihedral angles by holding a ruler along these lines.

The horizontal tail plane has a downward angle of ten degrees.

Look down the nose of the model, and straighten any bends or twists in the fuselage or wing.

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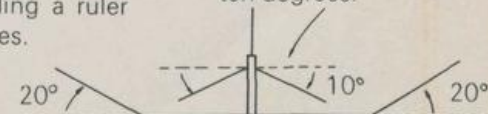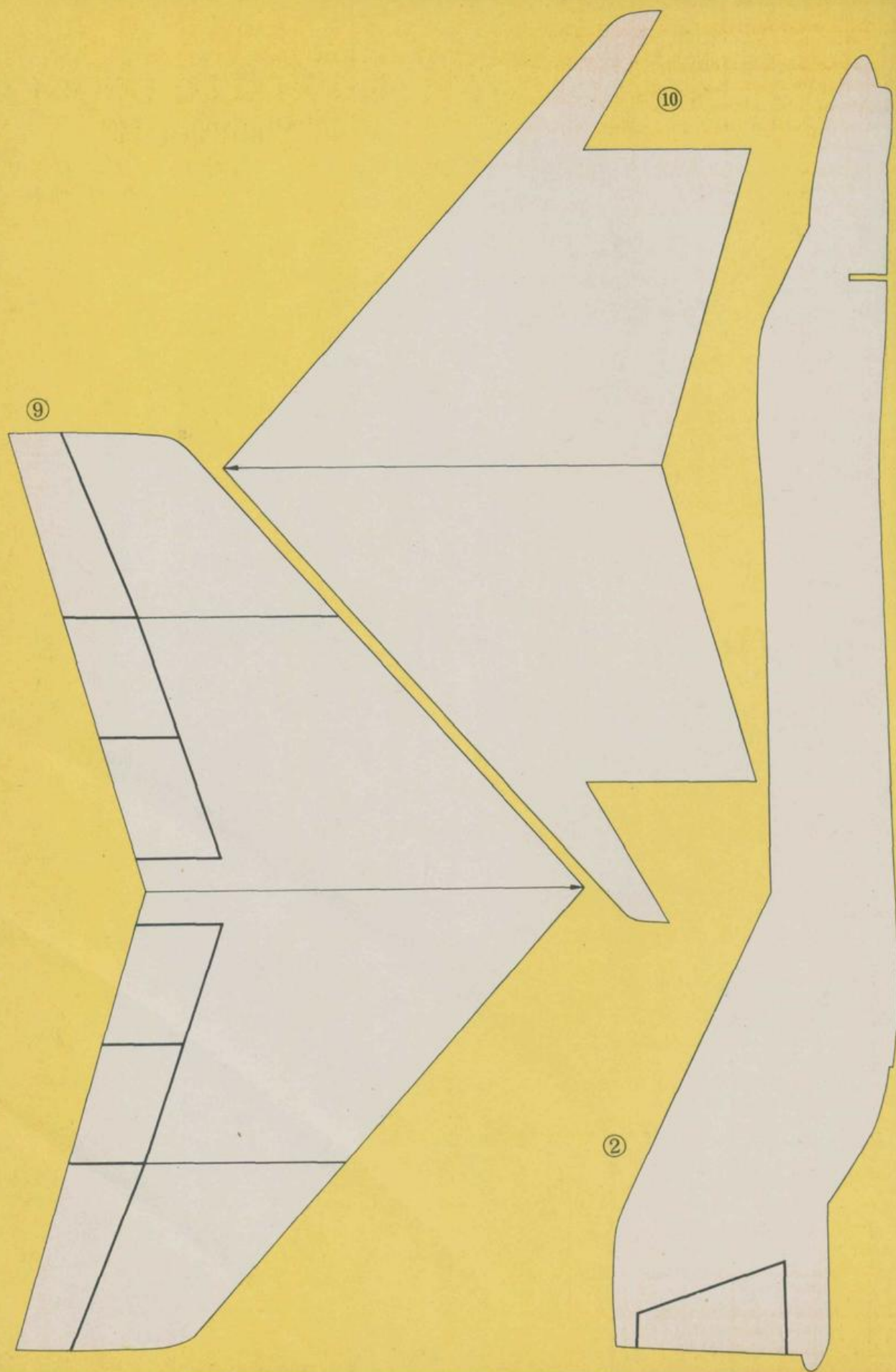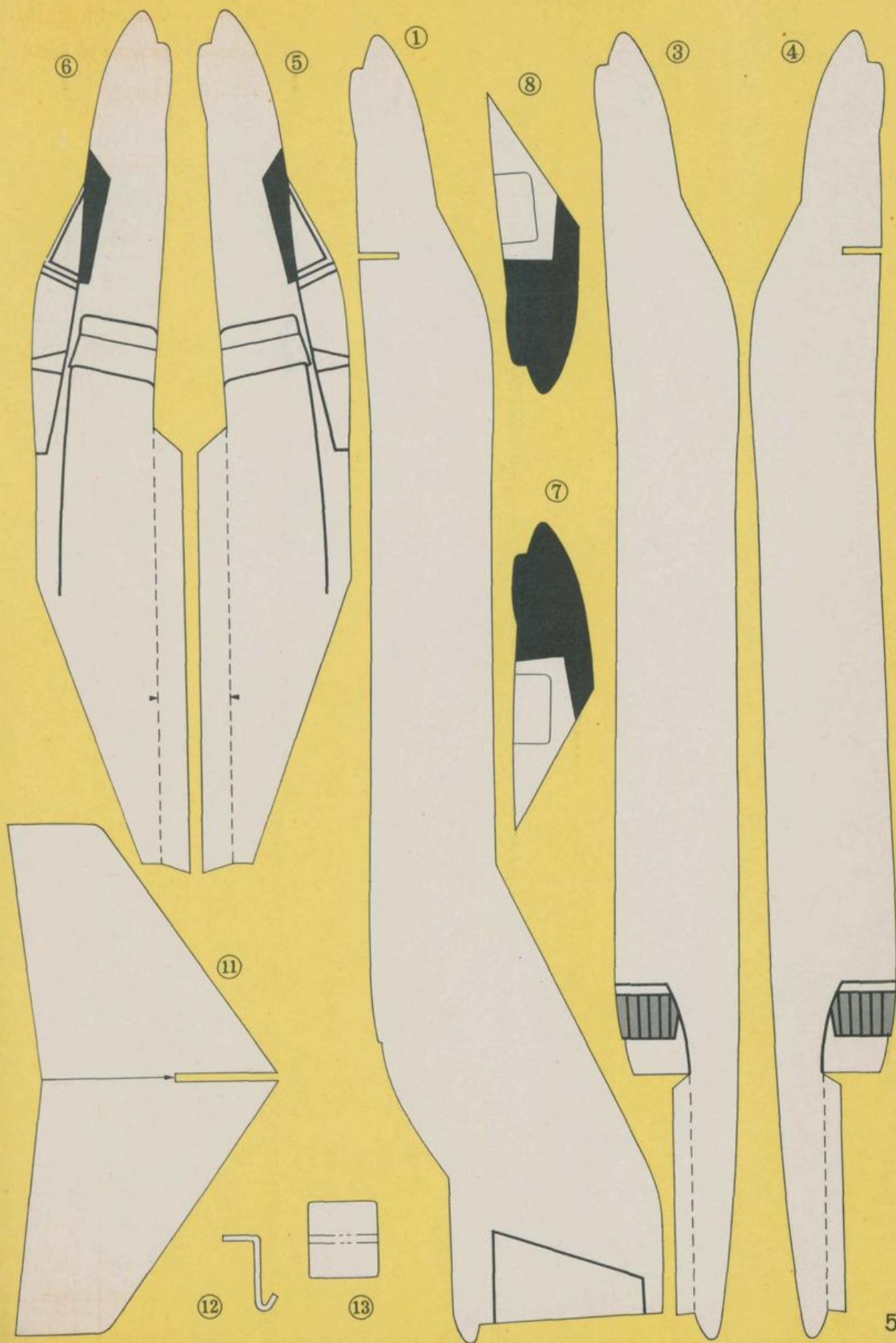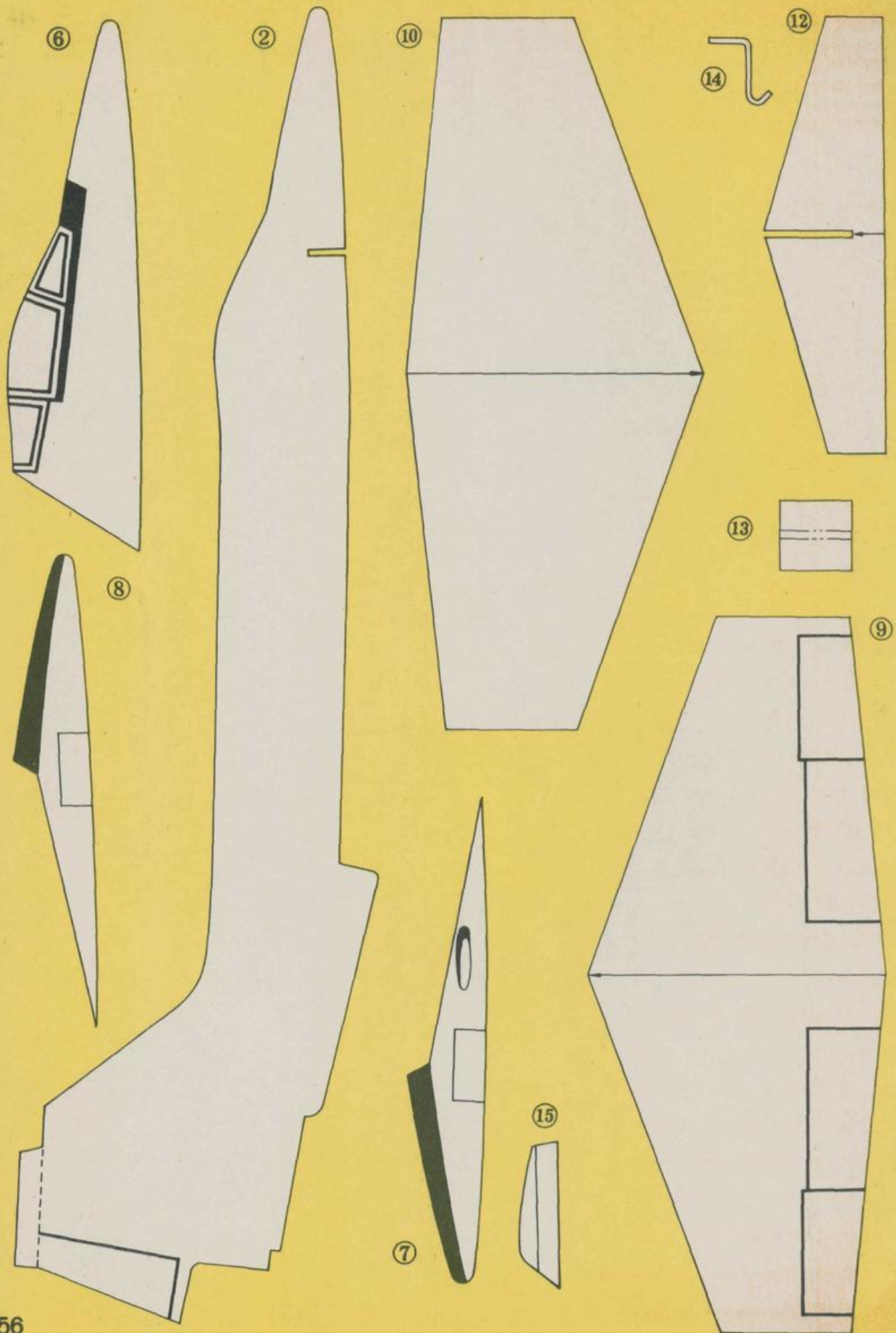
HAWKER SIDDELEY
"Harrier"

GLUING THE PARTS TOGETHER

Glue the tail sections together before gluing to the fuselage.

Glue wing backing ⑨ to wing ⑧ and then to the fuselage.

Glue the fuselage parts together in the order shown.

Bend a paper clip into the shape as shown ⑫ and insert it into the fuselage. Glue a paper cover ⑬ over it to keep it in place.

MAKING ADJUSTMENTS

The center of gravity in this model should align on the ▲ mark on the wing position without adding any weight.

Round the surface of the wing with your fingers.

Make an approximately 5 degrees downward bend in the wing.

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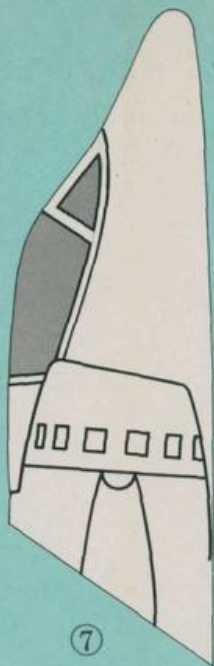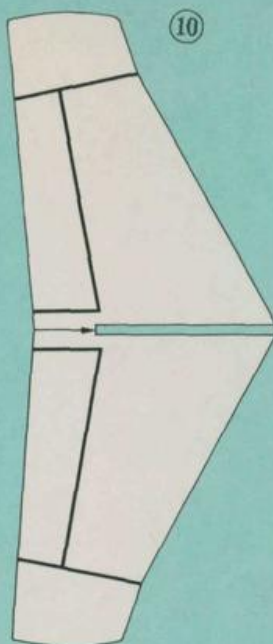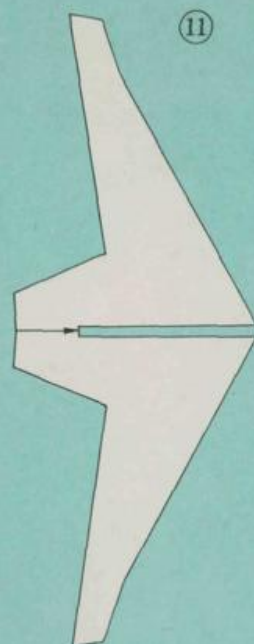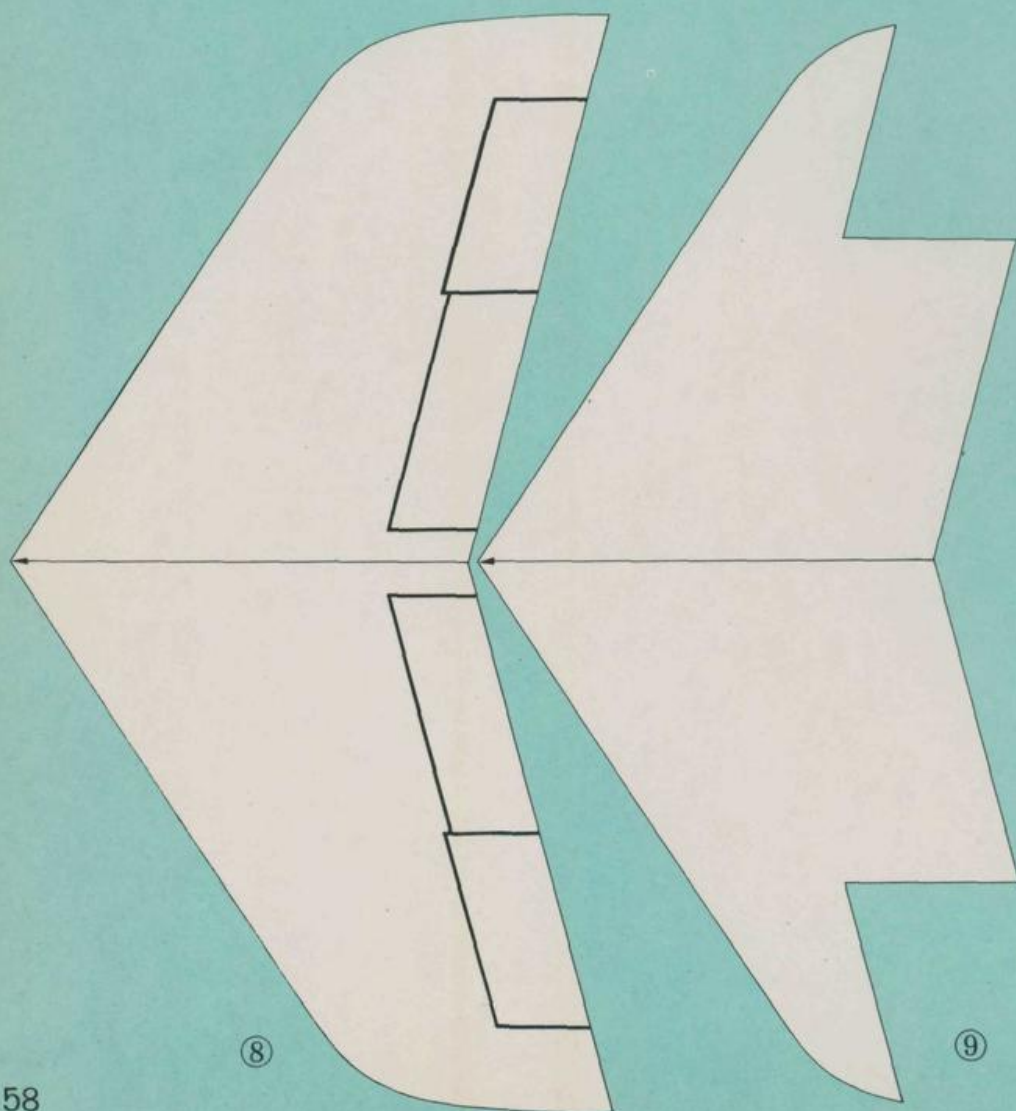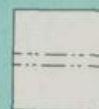
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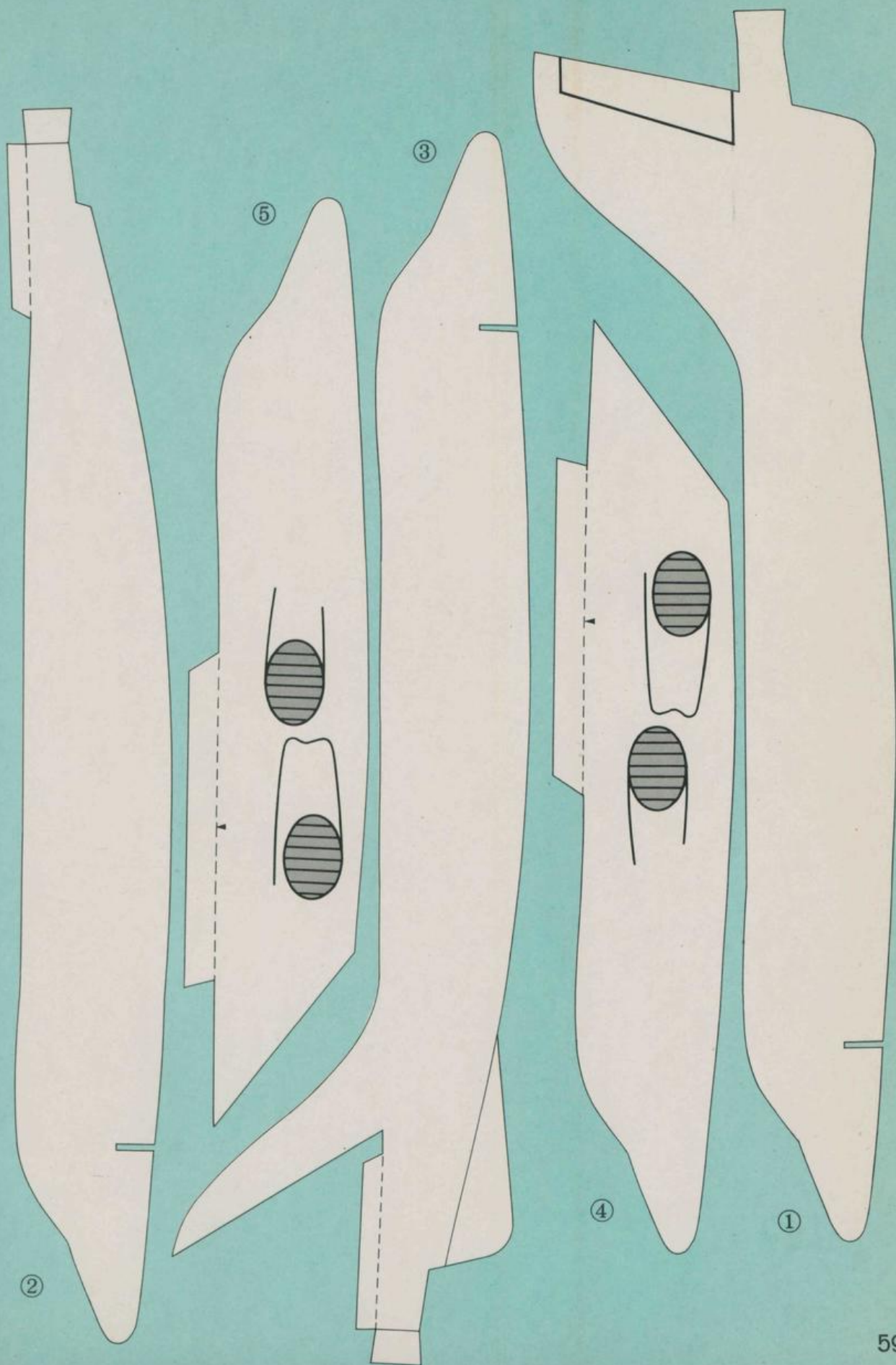
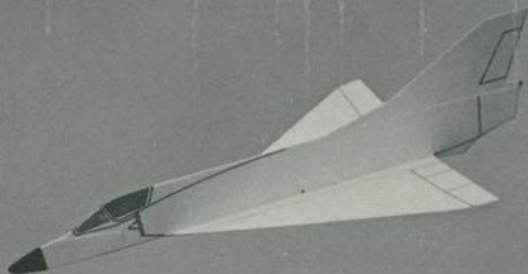
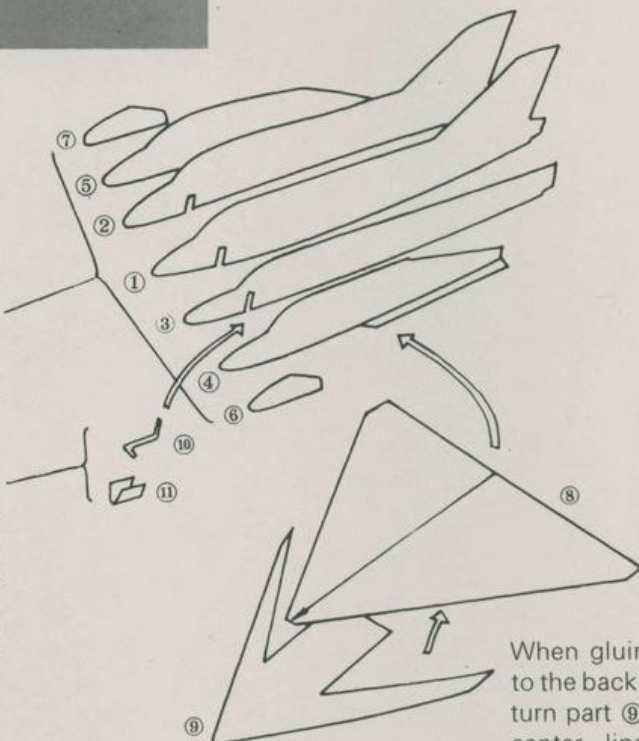
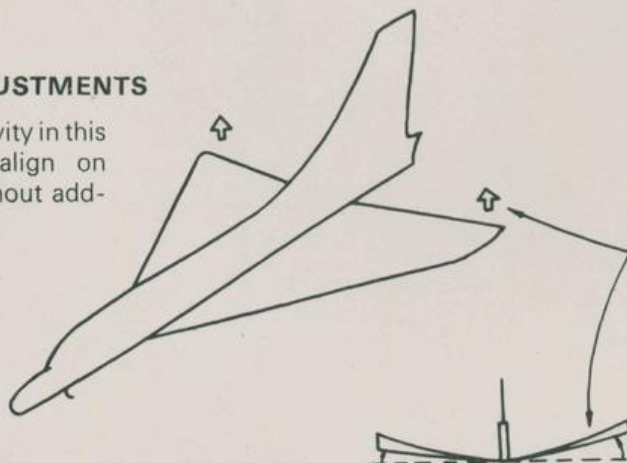

DASSAULT "Mirage III"

GLUING THE PARTS TOGETHER

Since this model is difficult to launch by hand, add a hook, and launch it with a rubber-band catapult.

Glue the fuselage parts together in the order shown.

Bend a paper clip into the shape shown in ⑩, and insert it into the fuselage. Glue on paper cover ⑪ to keep it in place.

When gluing part ⑨ to the back of part ⑧, turn part ⑨ over the center line of the bottom surface to reveal the center line, making it easy to glue the wing to the fuselage.

MAKING ADJUSTMENTS

The center of gravity in this model should align on the ▲ mark without adding any weights.

Bend the trailing edge of the delta wing up slightly.

10–15 degrees dihedral angle.

If the model flies in circles rather than a straight line make the adjustments as explained in the section for flying tne "Concord".

③

⑧

⑨

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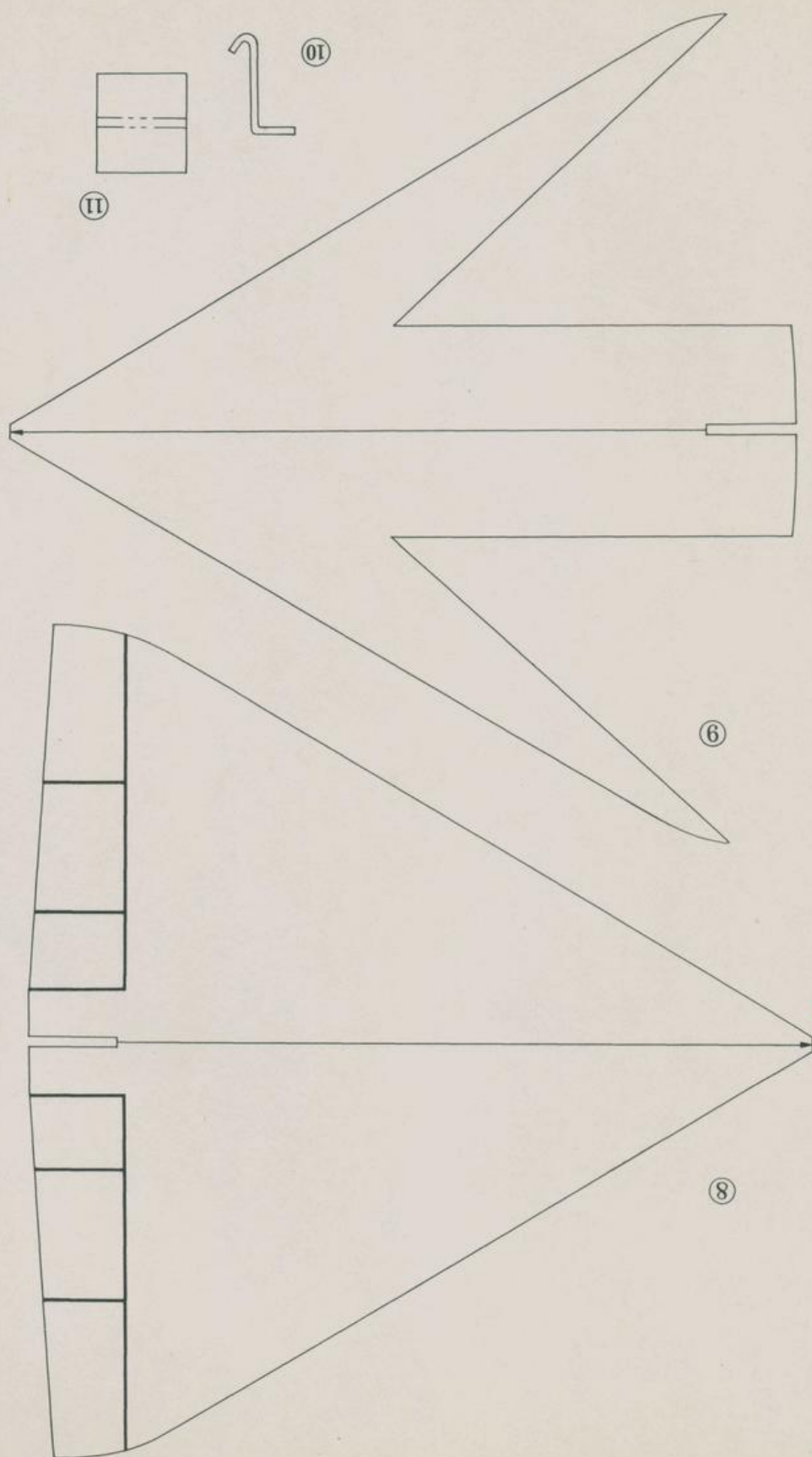
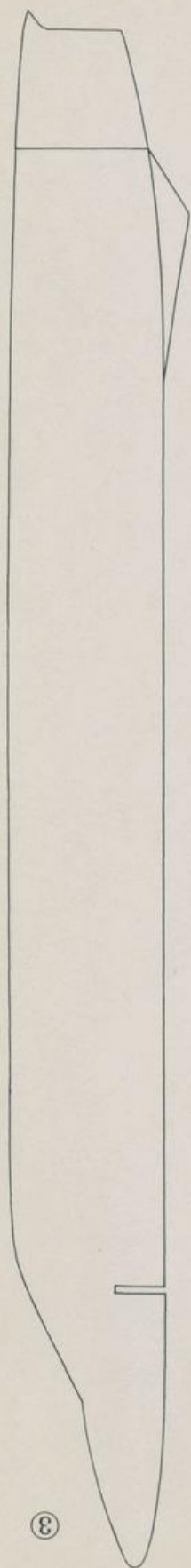
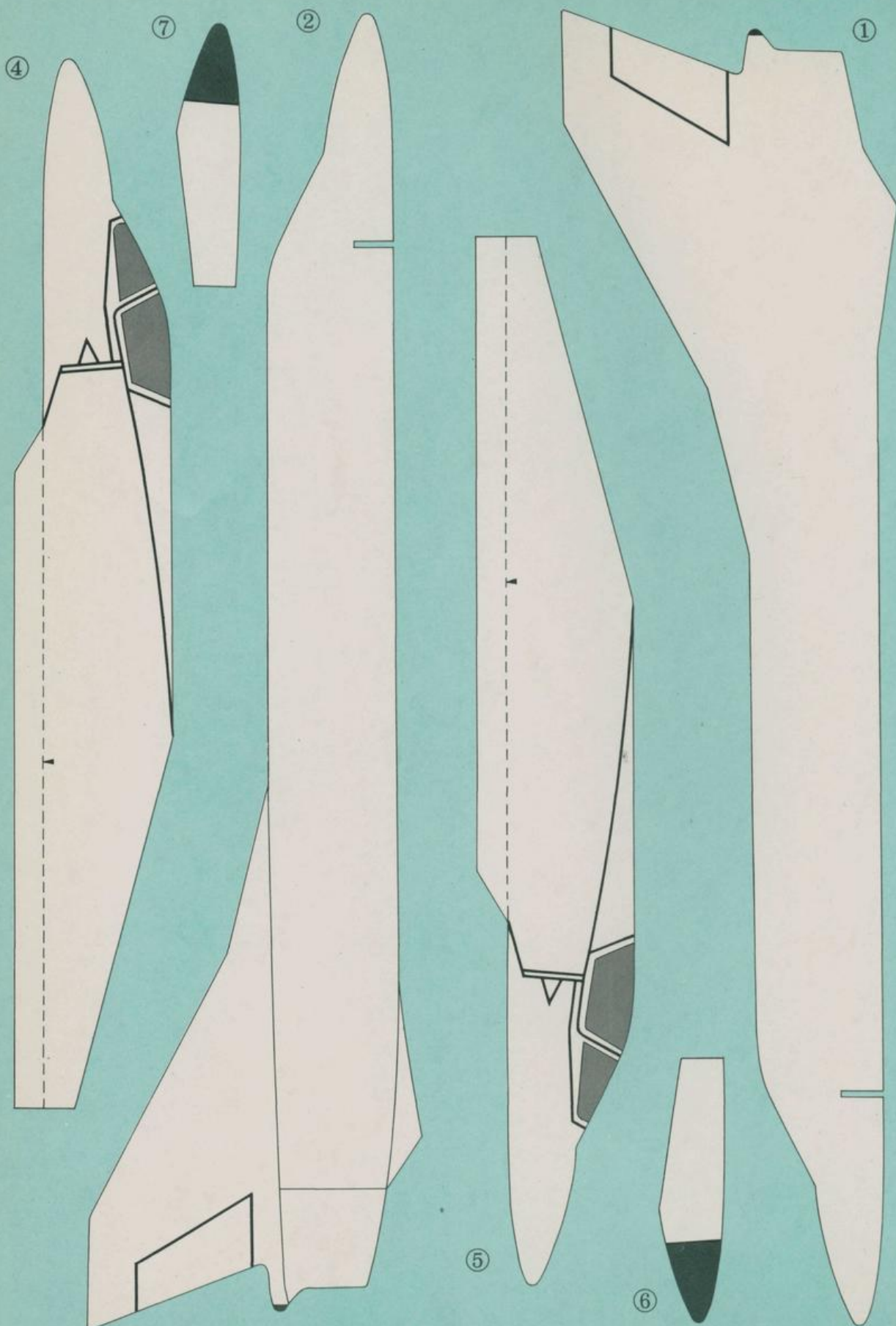

Patterns for Flying Models from Aircraft Profiles

If you have ever made tabletop scale models you have probably wished you could see them fly. A paper airplane based on the profile of an actual aircraft is not an exact scale model, but it will fly well and is not very difficult to build.

High-wing models are stable and easy to hold.

[8-1] Low-, mid- and high-wing models compared; high wings are best.

CHOOSING THE TYPE OF PLANE

If you already have a plane in mind, read how to make the pattern. But those who have not yet decided should keep the following points in mind.

a. High-wing planes have more stability than low-wing ones and are easier to hold. In attaching the wing to a mid-wing plane, you must cut a slit in the fuselage. Since this is troublesome, the high-wing type is easier to build and to fly (8-1).
b. In order to align the center of gravity in stub-nosed planes a lot of weight on the nose is necessary. Because this makes the plane heavy, it is better to avoid this type if possible, although you can extend the nose slightly as shown in 8-2 to decrease the amount of weight on the nose.
c. Landing gear or wing struts tend to be easily broken when they strike the ground. They also develop parasite drag in flight; therefore do not use them. In addition, attempt only the simplest bi-wing planes (8-3).

Few planes fill all these conditions, but try to find one which meets most of them. The planes in this book, chosen from among the world's most famous, generally meet the above requirements.

Stub-nosed planes, a type of fighter used before and during the Second World War, contained an air-cooled engine in the nose. Therefore, the weight of the engine compensated for the shortened nose (8-4, a). On the other hand, jet planes carry comparatively light jet engines in the fuselage, and the total weight is distributed evenly. In terms of weight distribution, an unweighted paper airplane resembles a jet.

[8-2] If the nose of a paper model stub-nosed aircraft is extended, less weight will be required for balance.

[8-3] Select only simple bi-wing planes.

The F-104 "Starfighter" and the F-4 "Phantom," require no added weight because the distribution along the fuselage is balanced. In other words, jet planes make better paper models than piston-engines.

MINIATURING AND ENLARGING

First choose the plane you want to copy from an airplane magazine or yearbook; I will show you how to make whatever size pattern you want from the airplane profile. Next decide the size you want the model to be; a fuselage length of from six to ten inches takes best advantage of the strength of Kent or drawing paper.

The diagram that you have found in the book must be adjusted in size to match the length you have selected for your model. Assume that the diagram in the book is four inches long and that you have decided on a fuselage length of eight inches. You must double the dimensions of the original diagram.

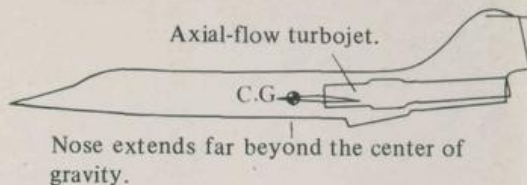
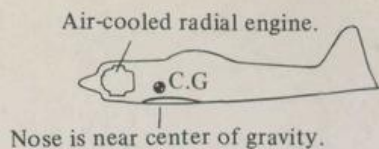
In simple cases, conversion of the main measurements is easy, but some of the small details are troublesome. You can solve this difficulty, however, by using proportional dividers (8-6), in effect no more than a pair of compasses joined top to top in such a fashion that the legs can be opened and closed as required. Loosening the screw at point P (8-7) changes the proportional lengths A : a. For instance, if the proportion between A and a is two, length EF will always be twice length ef. To double the size of a photograph, therefore, measure it with the small end of the proportional dividers, and transfer the enlarged measurements to paper by using the large end.

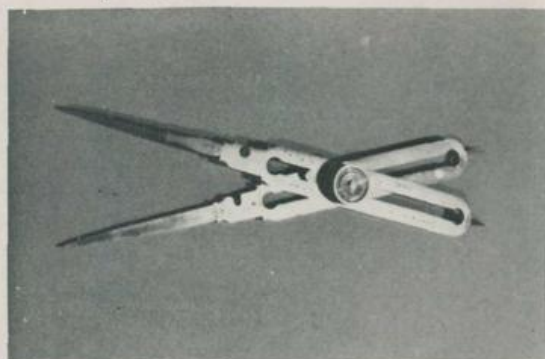
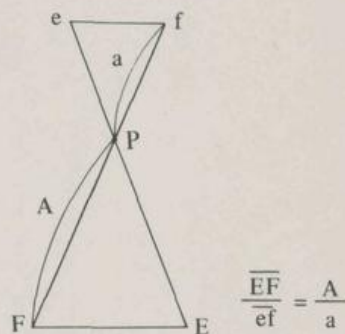
If facilities are available, you might photographically enlarge the original diagram.

MODIFICATIONS FOR BETTER MODELS

The many differences between a paper model and a real airplane demand a number of alterations in addition to measurements.

1) Since there is no pilot aboard, the paper model must be more stable than a real aircraft. In order to accomplish this, the dihedral angle of the main model wing must be increased by from five to ten degrees more than that of the original. The angles in 8-8 are correct for most planes. On the other hand, swept-back wings, which increase lateral stability, permit smaller dihedral angles.

Air-cooled radial engine.
C.G
Nose is near center of gravity.
Axial-flow turbojet.
C.G
Nose extends far beyond the center of gravity.

[8-4] The difference in weight distribution in a piston engine plane and a jet plane.

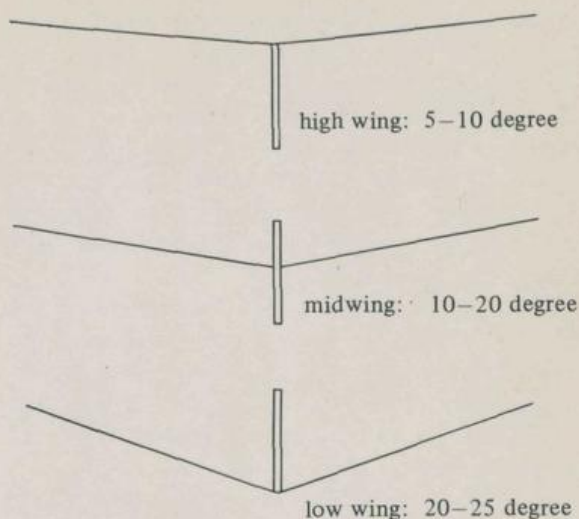
[8-5] Drawings of actual aircraft plans can be found in airplane magazines and yearbooks.

[8-6] Proportional dividers.

[8-7] The principle of the proportional dividers.

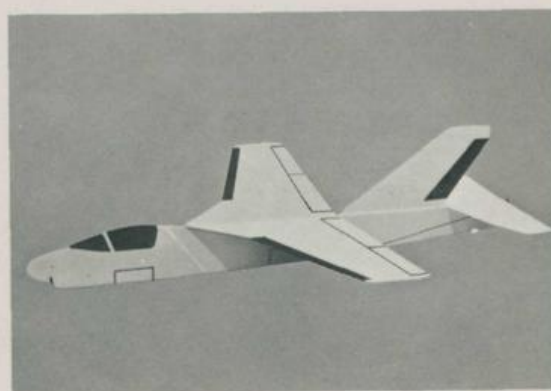
Although to increase longitudinal and directional stability, the areas of the horizontal and vertical tail planes must be increased, the following points about vertical stabilizers deserve careful consideration. Because the fuselage and the engine nacelles of actual aircraft are rounded, the body surface area in front of the center of gravity has no great effect. Quite the opposite is the case, however, with paper models, all of which have flat fuselages. Body surface-area balance is especially vital in models of long-nose planes, like the F-104 "Starfighter." Accommodate by increasing the area of the vertical tail plane by from thirty to fifty per cent more than that of the actual plane.

Sometimes, for construction convenience, the horizontal tail plane must be moved slightly forward or backward. But since the area of the horizontal tail plane times the distance from it to the aircraft's center of gravity determines the efficiency of the tail, alterations in its position entail changes in its area. In other words, if the horizontal tail plane is moved twenty per cent forward, its surface area must be increased by twenty per cent. It must be decreased by twenty per cent if the position is altered by twenty per cent to the rear. This principle applies to both horizontal and vertical tail planes.

2) The latest high-speed jets, outfitted such high lift equipment as flaps and boundary-layer control devices, can take-off and land at low speeds. Their wing areas,designed for high-speed flight only, are therefore very small. Since paper models with similar wings fly too fast and consequently crash easily, their wing areas must be increased twenty to fifty per cent more than the original; some of the wings in this book have been enlarged slightly.

3) Modern planes flying at speeds close to that of sound often have swept-back wings, but the low speeds of paper models make them unnecessary. In fact, they are a liability, since slow-flying planes with swept-back wings tend to wing-tip stall and flip-fall. To solve the problem, reduce the sweep of the wings as shown in 8-10.

To determine the center of lift – the point to which you must adjust the center of gravity – for a swept-back-wings model, make a diagram like the one in 8-11. The shaded area represents the wing; t_t stands for the chord length at the wing tip, and t_r for the chord length at the wing root. Extend the line t_t by the chord length t_r, and the line t_r by the chord length t_t. Connect the two points (T and R) at the ends of the extentions with a dotted line. Bisect the original t_t and the original t_r, and connect the two center points with a dotted line.

[8-8] The proper dihedral angles for different wing positions.

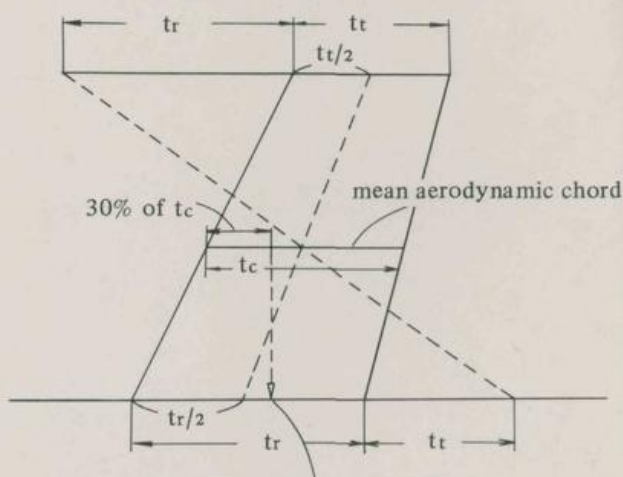
(a) actual aircraft

(b) Paper model – The vertical tail plane is moved slightly forward, and the horizontal tail plane slightly back to make construction easier.

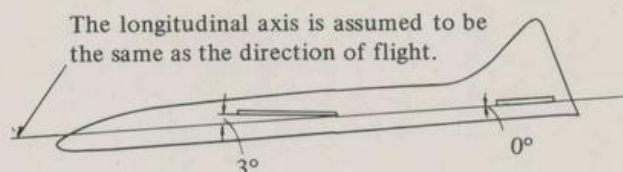
[8-9] An example of a paper model with the tail moved farther back than on the actual plane.

The intersection of these two dotted lines will be point M. Draw a line through point M that is parallel to the center line of the plane's fuselage. This line passing through point M will be the mean aerodynamic chord length t_c of the wing. The center of gravity should be aligned at a point thirty per cent of t_c from the leading edge. With straight wing models, simply use the real chord length of the wing as t_c.

4) The longitudinal axis is considered to be the same as the plane's direction of advance. After drawing the horizontal axis on the model pattern, design the main wing to join this axis at three degrees and the horizontal tail plane to join at zero degrees (8-11).

5) Because they inevitably crash into walls and other obstacles, paper models must be strong if they are to give long-lasting enjoyment. Reinforcing the nose with several layers of paper provides protection in collisions. To reduce the number of parts that might drop off or break, always eliminate wing-tip tanks, large pods beneath the wings, struts, and landing gear (8-13). Though this alters the configuration of the plane slightly, it will not destroy the general image of the original.

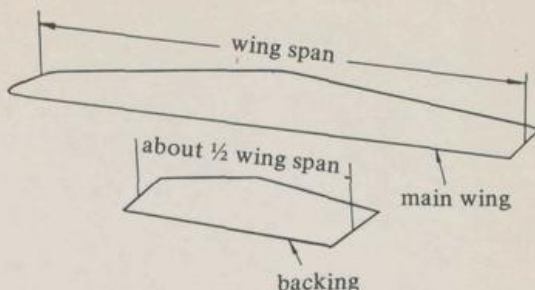
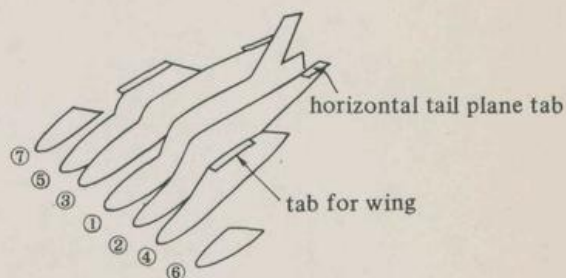
[8-10] Decrease the swept-back angle in your model to less than that of the actual aircraft (either a or b)

[8-11] Determine the mean aerodynamic chord; then align it with the center of gravity.

[8-13] Wing-tip tanks, leading-edge engine pods, and other projections should be omitted from flying models.

[8-12] The angle of attachment of the main wing and the horizontal tail plane.

PATTERNS FOR PARTS

Having explained the general approach to reproducing an aircraft in model form, I must now explain how to reduce the whole to constituent parts that can be cut out and assembled. The best guide is the patterns in this book; study them closely, and pay special attention to the following points.

1) The wings must be reinforced with an additional strip of paper about half the length of the wing span (8-14).

2) The fuselage is composed of several pieces as shown in (8-15): the central strip including the vertical tail plane ①, side strips ② and ③, body parts ④ and ⑤, and nose reinforcements as needed (⑥ and ⑦). Tabs for attaching the horizontal tail plane are included in parts ② and ③; those for attaching the wings in parts ④ and ⑤. The ends of parts ④ through ⑦ should be cut on a diagonal since right-angle cuts will cause abrupt decreases in fuselage strength and a resulting danger of bending.

[8-14] Make a backing to increase the strength of the center of the wing.

[8-15] Fuselage components

About the Author:

Born in 1926, Yasuaki Ninomiya, winner of the grand prix at the First International Paper Airplane Contest (Pacific Basin Division) held in San Francisco, in 1967, is a graduate of the communications engineering department of the Tohoku University (class of 1951) and a doctor of engineering.

He has been interested in airplanes since his childhood. Today, in addition to his important duties at the Electrical Communications Laboratory of the Nippon Telegraph and Telephone Public Corporation, he occupies his leisure time by devising aviationally sound advances for his collection of sleek, high-performance paper craft. As a widely respected authority in this field he has won particular plaudits for the simple beauty of his models.

He says that he finds their relationship to industrial design and their mechanical functionality the most fascinating aspects of paper airplanes. His careful calculations in designing produce airplanes sound enough to come in way ahead in duration and distance of flight contests at the San Francisco meet.

He contributes a series of popular paper-airplane designs to a widely distributed children's science magazine. A recently qualified private pilot, he flies frequently with his charming wife, whom he met through his aviation activities.

BOEING 747 "Jumbo Jet"

CESSNA 210 "Centurion"

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